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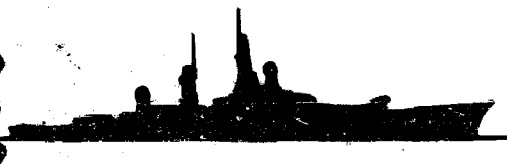
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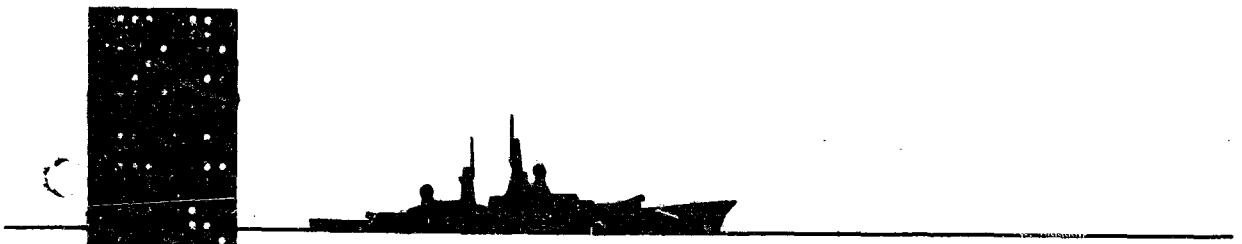
PROGRAMMING SYSTEM FOR NUMERICALLY CONTROLLED FLAME CUTTING OF SHIPS PARTS

OPERATING MANUAL

406 280

DDC

TODD SHIPYARDS CORPORATION
LOS ANGELES DIVISION SAN PEDRO CALIFORNIA



PROGRAMMING SYSTEM FOR NUMERICALLY CONTROLLED FLAME CUTTING OF SHIPS PARTS

OPERATING MANUAL

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Technical Report 5.0.0
Volume 4 of Final Report
Contract NObs-4427

March 1963

TODD SHIPYARDS CORPORATION
LOS ANGELES DIVISION SAN PEDRO CALIFORNIA

FORWARD

This publication is one of six volumes of the final report on Mathematical Ship Lofting and Numerical Control of Shipyard Fabricating Equipment. The work reported on herein was performed under Bureau of Ships Contract No. NObs-4427, Code 770, during the period from April 1961 to March 1963.

The volumes of this final report have the following titles:

Vol. 1. Project Summary Report (Technical Report 9.0.0)

Vol. 2. Mathematical Ship Lofting -
Part 1. - Theory (Technical Report 1.0.0-1)
Part 2. - Operating Manual (Technical Report 1.0.0-2)

Vol. 3. Mathematical Ship Lofting - Summary Report (Technical Report 1.5.0)

Vol. 4. Programming System for Numerically Controlled Flame Cutting of Ships Parts - Operating Manual (Technical Report 5.0.0)

Vol. 5. Development and Testing of Programming System for Numerically Controlled Flame Cutting of Ships Parts - Summary Report (Technical Report 5.5.0)

Vol. 6. Numerically Controlled Shipyard Fabricating Equipment - Summary Report (Technical Report 3.0.0)

The work was accomplished by the Research and Development Group of the Los Angeles Division of Todd Shipyards Corporation, San Pedro, California. Mr. Thomas G. Smith was Project Manager for the work, and Dr. Henry A. Schade of the University of California, Berkeley, was Principal Consultant.

The Todd Staff, whose contributions and participation during the Project were responsible for its successful culmination, consisted of:

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Bruce L. Baird, of Bruce L. Baird Inc., and O. Dale Smith of North American Aviation Inc., served as consultants on this work.

Special thanks go to the following individuals who gave of their own time to advise on the work:

Mr. Tom Rothrock, Northrop Corporation
Mr. Richard Aggen, Northrop Corporation

The Project is indebted to the following firms and organizations and to their representatives who contributed significantly to the effort:

IBM Corporation
D. A. Anderson
William Rogers
George Gerson
R. E. Laskey
Milton Drandell
H. Daigle
Bill K. Simmons

Univac Division, Sperry Rand Corp:
Gastone Chingari
Ray Reeves

Rand Corporation:
M. L. Juncosa
Philip Wolfe

Air Reduction Co:
J. E. Waring

Linde Co:
A. Miller

Armour Research Foundation:
S. Hori

To the following representatives of the Navy Department go our sincere thanks for their assistance and guidance during the work:

Bureau of Ships:
Captain W. S. Dawson
Captain F. E. Gorman
Comdr. William Harrison
Mr. T. H. Sarchin
Mr. G. Vidlak

David W. Taylor Model Basin:
Dr. Feodor Thielheimer
Dr. P. C. Pien
Mr. William Starkweather

For their support and continued interest, our thanks to Mr. W. Taylor Potter and Mr. Karl Fixman, of the U. S. Maritime Administration.

To Admiral R. K. James, Captain D. L. Carroll Jr., Captain T. J. Banvard, and Mr. Ed Kemp of the Bureau of Ships, are due the gratitude of the industry for initiating this work. The Project is particularly grateful for their early assistance in getting the work under way. To Mr. Ed Kemp go our sincerest thanks for his deep interest in this work and for his continued guidance to the Project.

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Section I

INTRODUCTION

This Operating Manual is for a Programming System for Numerically Controlled Flame Cutting of Ships Parts. Computer programs, complete with operating instructions, flow diagrams, and program listings, are included. Sample programs and special instructions are provided to clarify the use of the System.

The System presented herein has been developed using:

- IBM-1620 computer, 60K memory, with card and tape input and output
- California Computer Products No. 560 digital plotter, connected on-line to the computer
- IBM No. 026 printing key punch
- Flexowriter No. NC-1
- Air Reduction Company "Tape-O-Graph" flame cutting machine, with General Electric Co. Mark Century director

Because this equipment was used in developing the System, the programs written by the Project and presented herein are for these specific units.* The System Flow Diagram, using the AUTOMAP II** parts programming language and the equipment specified above, is shown in Fig. I-1.

Programs can be written for and, in some instances, are already available for similar equipment of other manufacturers.

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*The presentation of these computer programs does not constitute endorsement or recommendation for any specific product, but are presented as a guide to the requirements for any system developed around any combination of equipment.

**Programmers' Manual available to users directly from IBM Corp.

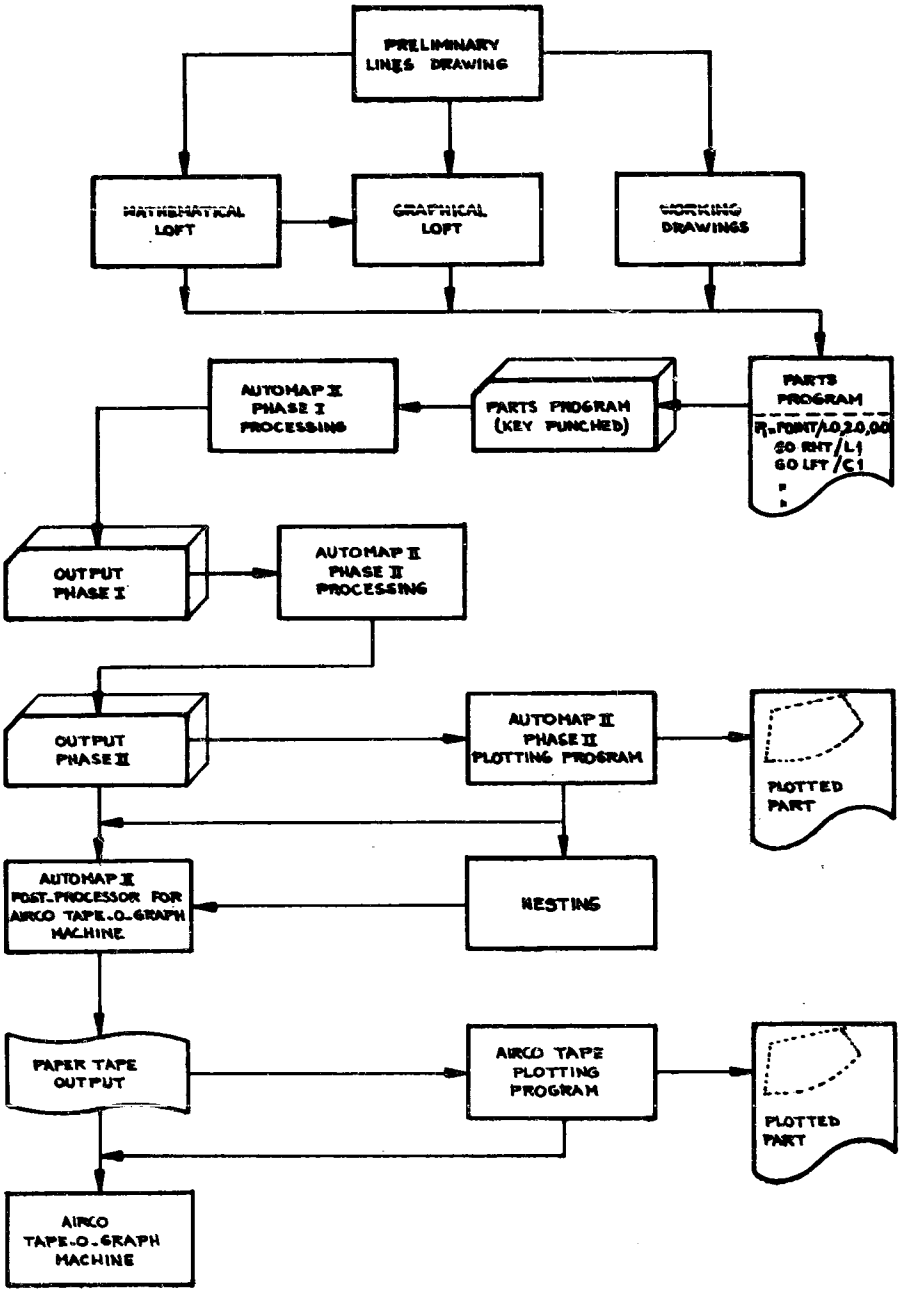


Fig. I-1 System Flow Diagram for Numerically Controlled Flame Cutting

The System presented here has had imposed upon it the requirement that it be able to accept information from the engineering/working drawings in the form presently used. This ability may lead to the earlier use of the System, but improved design formats based on numerical control requirements would allow for more efficient programming.

Section II

THE PROGRAMMING SYSTEM

INPUT INFORMATION

The input information with which the parts programmer starts is obtained from the working drawings and from the loft. The loft information can come from either the common graphical loft or from a mathematical loft.

A. Graphical Loft

If the programmer is to obtain his information from a graphical loft, he must have all of the final corrected offsets for frames, including all waterlines, buttocks, offsets for sight edges of decks, longitudinals and shellplates. In some instances, it may be necessary to have more offsets than just the normal amount used by the graphical loft. Experience will indicate the optimum number required.

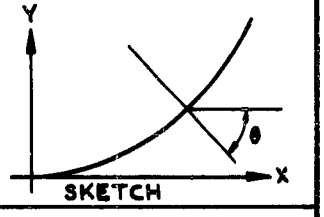
These offsets must be accurately measured and verified. If a dimension is misread, which is not uncommon, a bad part will be produced. A point reading X-Y plotter could be used to overcome this problem and to speed up the process of obtaining offsets.

For parts programming, the offsets should be listed in a different way than is ordinarily used. A suggested form for such listing is shown in Fig. II-1.

BASIC DIMENSIONS

HULL NO. DLG-33 FRAME NO. 58

MOLD LINE OF HULL				STRINGERS				DECKS		
W.L.		BTK.								
X	Y	X	Y	NO.	X	Y	θ	NAME	X	Y
0	0	0	0	1	30.19	2.85	80 5	MAIN DK	264.12	394.81
12.0	0	24.0	1.77	2	58.00	10.56	71.5	01 LEVEL	278.19	499.56
66.93	24.0	48.0	7.31	3	83.63	22.19	64.0	1ST PLAT	231.56	292.25
121.43	48.0	72.0	16.56	4	109.25	38.44	55.0			
145.65	72.0	96.0	29.31	5	127.94	53.69	48.0			
162.82	96.0	120.0	46.69	6	146.50	73.00	40.0			
175.45	120.0	144.0	70.06	7	161.42	93.50	32.1			
185.46	144.0	192.0	168.31	8	175.00	119.00	24.4	SHELL SIGHT EDGES		
201.35	192.0	240.0	318.31	9	192.40	136.25	22.2	NAME	X	Y
215.86	240.0									
230.19	288.0			13	193.85	168.0	20.5	A	23.94	1.31
245.48	336.0							B	104.44	34.81
261.58	384.0			14	215.75	239.63	16.5	C	153.12	81.50
268.42	432.0							E	199.19	184.81
273.95	480.0							F	228.38	281.94
								KNUCKLE	263.56	389.81



SKETCH

Fig. II-1 Format for Listing Loft Data

B. Mathematical Loft*

If the parts programmer receives his information from a mathematical loft, he must be given a similar printout and a deck of cards containing the same information furnished by the graphical loft. In Addition, he must have cards containing the coefficients of the equations which define the hull form at the frames. These cards must contain the limits of the equations, i.e., the points of beginning and ending of that part of the curve defined by that particular equation, and the frame number defined. Typical punched cards, giving hull coefficients and coordinate data, are shown in Fig. II-2.

The programming language specifications require that the language be capable of accepting the coefficients of cubic equations of the form $X = ay^3 + by^2 + cy + d$. If the hull is defined in another manner, such as by conic equations, then the parts programming language selected must be capable of accepting that form of input.

C. Working Drawings

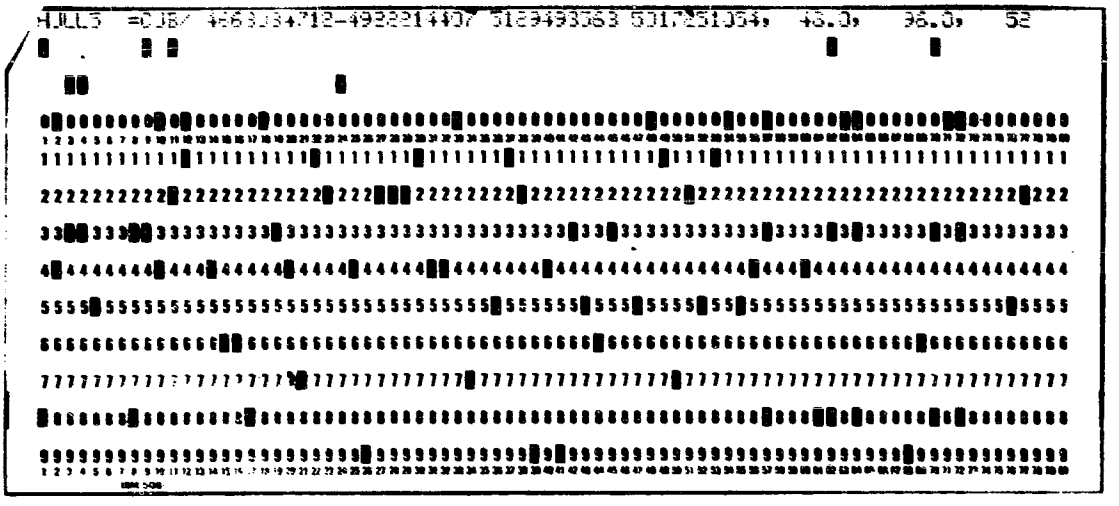
Working drawings as presently dimensioned do not give the information in the form required by a parts programmer; therefore, the programmer must convert much of the dimensional information to coordinate form.

If the hull form information is to be loft offsets, it may be more convenient for the programmer to place this information on the working drawing. Fig. II-3 shows a sample working drawing to which coordinate identification has been added.

---

* Assumes the use of the mathematical lofting system developed under Contract NObs-4427 (Ref. 1)

CARD CONTAINING CUBIC EQUATIONS



CARD CONTAINING COORDINATE DATA

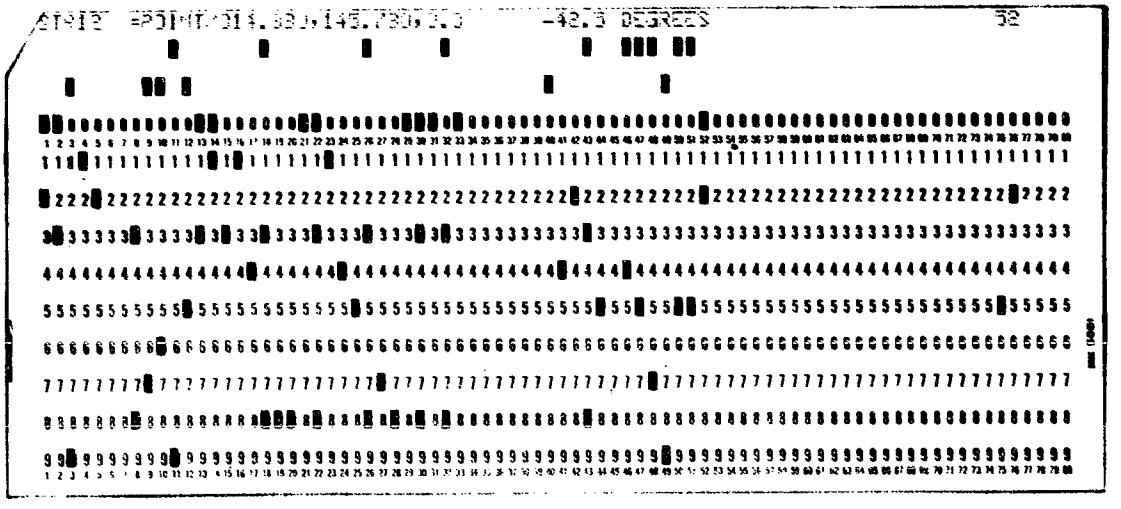


Fig. II-2 Cards Containing Coefficients or Coordinate Data from Mathematical Loft

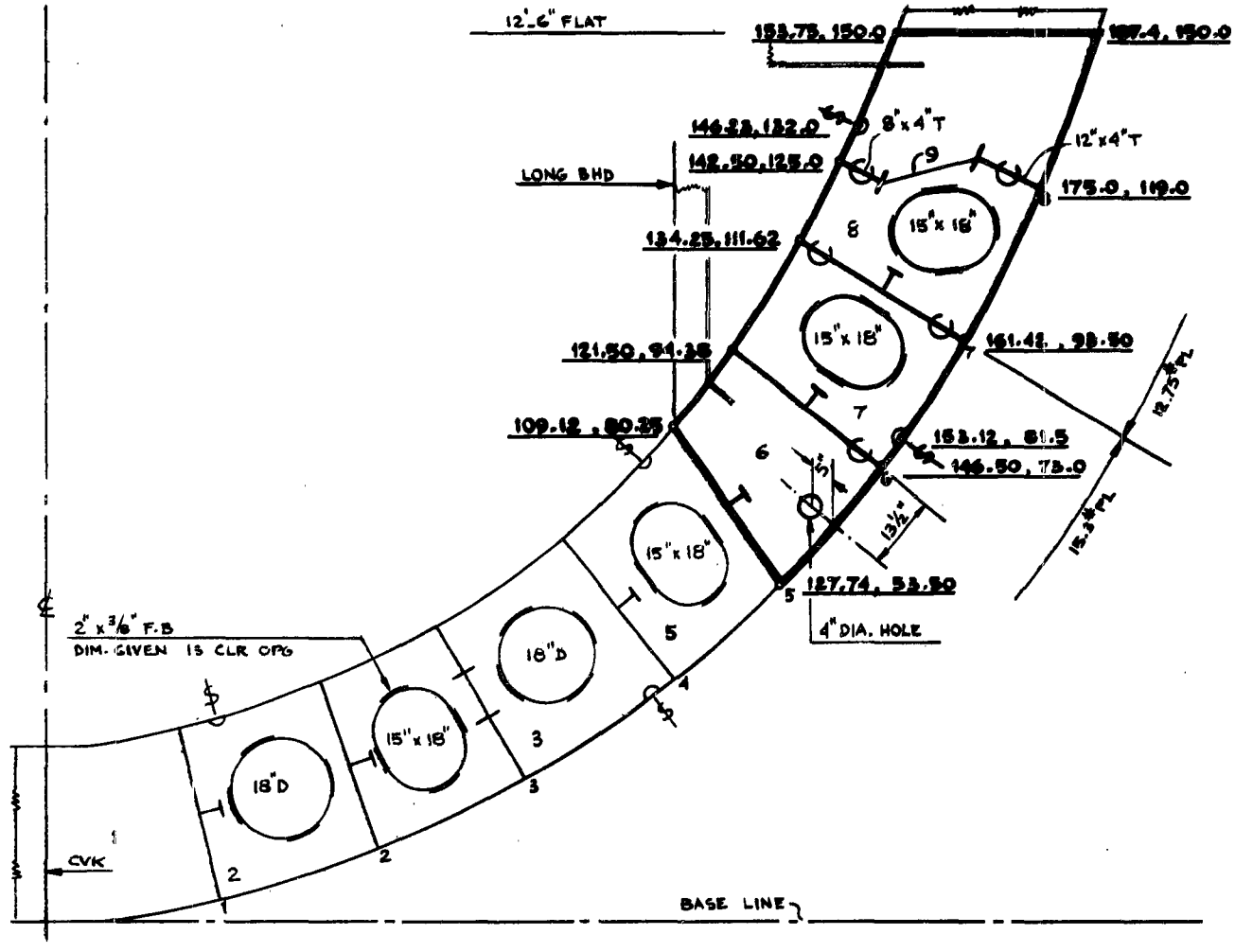


Fig. II-3 Sample Working Drawing to Which Coordinate Identification Has Been Added

PROGRAMMING THE PART

Once having the input information in the format desired, the programmer can then proceed to program parts for cutting. He can program these parts either manually or by computer, depending upon the complexity of the part.

A. Programming for Tape Punch Typewriter

For the simplest parts, the programmer may find it more efficient to prepare the program for a tape-punching typewriter. To do this, he prepares a written program, listing all of the instructions needed to guide the machine. Generally, he can direct the machine in straight line or circular cut only.* He must know the beginning and ending points of all lines and their intersections with circles. If he must define curves,** and this is not recommended in manual programming, it is necessary that he segment the curve in a series of straight lines of such length that the curve will be simulated within the desired tolerance.

Manual programming of rectangular parts is relatively simple, especially if the corner points are known. However, one can readily see that the complexity of programming increases rapidly when it becomes necessary to find the points of tangency between lines and circles, intersections of lines and curves, or segment curves into a series of straight lines. In most of these cases, it is recommended the part be programmed by computer.

The programmer lists on a form all of the machine instructions in the sequence desired and in the format understandable by the

---

*Some directors have the additional capability of cutting parabolic curves.

**Other than circular arcs

machine director. This information is then punched into tape, using a tape-punching typewriter. This paper tape can then be fed into the machine director. A sample parts program is given in Appendix A.

Because the tape thus produced is used directly in the machine, nesting of multiple parts on a single plate must be done before programming, and the whole plate of parts programmed in sequence from the same axis. This type of nesting can be very time-consuming, and it will probably be more economical to program even the simplest of parts by computer if they are to be nested on a single plate.

If the burning machine to be used does not have automatic kerf compensation, the path which the flame takes must be defined, rather than defining the actual edges of the part. This is to compensate for the material removed.

B. Programming for Computer

In this method of programming, we depend upon the computer to solve all of the arithmetic calculations to:

determine points of intersection

segment curves

offset the flame path sufficiently to compensate for kerf width

We also have the computer complete the conversion of the data into punched tape with the hole pattern in a format acceptable to the burning machine.*

*Refer to Ref. 2 for a detailed explanation of computer parts programming language capability.

To program parts by computer, the programmer first describes the geometry of the part in the programming language selected; he then lists the operations the machine must make to cut the part.

By using MACRO instructions*, programming effort is greatly reduced. This time-saving feature is demonstrated in the part programs detailed in Appendix B, which includes:

The program using only the basic language capabilities of AUTOMAP**

The same program using six MACRO instructions

Ten MACRO instructions written to minimize programming of repetitious operations and functions

A library of punched cards containing these macros is maintained, and the appropriate cards are selected, as required by the programmer. The MACRO cards are read into the computer after the compiler has been inserted and before the actual parts program is used.

Once the offsets from the graphical loft, or the coefficients of equations from the mathematical loft are known, they, too, can be pre-punched and appropriately inserted in the program card deck. The fourth section of Appendix B shows the same program using this capability.

By using the two above-described features, savings in time required to write the programs for the sample floor is summarized as follows:

	Written Instructions Required	Programming Preparation Time
Program using only basic language capabilities	148	2.5 hrs
Program using six of the MACRO instructions	48	.8 hrs
Program using (a) MACROS, and (b) pre-punched coefficients & coordinates	25	.5 hrs

*See Page A-5 of Ref. 2 for complete description and use of MACROS
**For complete details in the use of AUTOMAP, see Ref. 3

The programming process as described thus far has been developed within the capability of language and equipment available to the Project. If a high-volume of programming work is available to justify rental costs, the process can be made significantly more efficient with:

Greater computer memory capacity to permit use of MACROS large enough to define similar repetitive parts completely

When the system is placed into full production operation, these and other improvements will undoubtedly be generated to make the process of programming parts more efficient. The fifth section of Appendix B indicates what may be expected to be typical programs for similar parts under a high-volume programming operation.

KEY PUNCHING THE PROGRAM (FOR COMPUTER)

The completed parts program next goes to a key punch operator who punches the input cards for the computer. Tape-punched computer input is not recommended, except perhaps in a very low-volume operation.

Experience has shown that a key punch operator skilled in normal business data card punching can be readily taught to punch numerical control tapes and cards.

COMPUTER OPERATION

After the cards are punched, they are supplemented with any pre-punched cards called for in the program to form the data input to the computer language program. MACRO cards are read prior to the data input, as previously stated.

The computer operating instructions are furnished with the language

programs (ref. 3) Training in the use of the parts programming language and in the operation of the computer is generally furnished free of charge by the computer manufacturer.

CHECKING THE PROGRAM

The parts program must be checked for accuracy before cutting a part. This checking can be done during the computer operation and at some phase prior to the post processing.

The procedure developed uses an "on line" plotter which is used to draw a reduced-scale picture of the part. Experience has shown that programming errors (as opposed to measurement errors) are readily discernible on a small-scale plot of the part and are usually also easily corrected at this time.

The plotting program and operating instructions for use with the AUTOMAP language, the IBM-1620, and the California Computer Products Co. plotter are included in Appendix D. Similar programs can be written for other languages, computers, and plotters.

A typical plot produced on a Cal-Comp plotter is shown in Fig. II-4, and Fig. II-5 shows the plot of a part containing programming errors to demonstrate how readily distinguishable such errors become. A typical part plot from a General Dynamics 4020 plotter, employing the APT language, is shown in Fig. II-6.

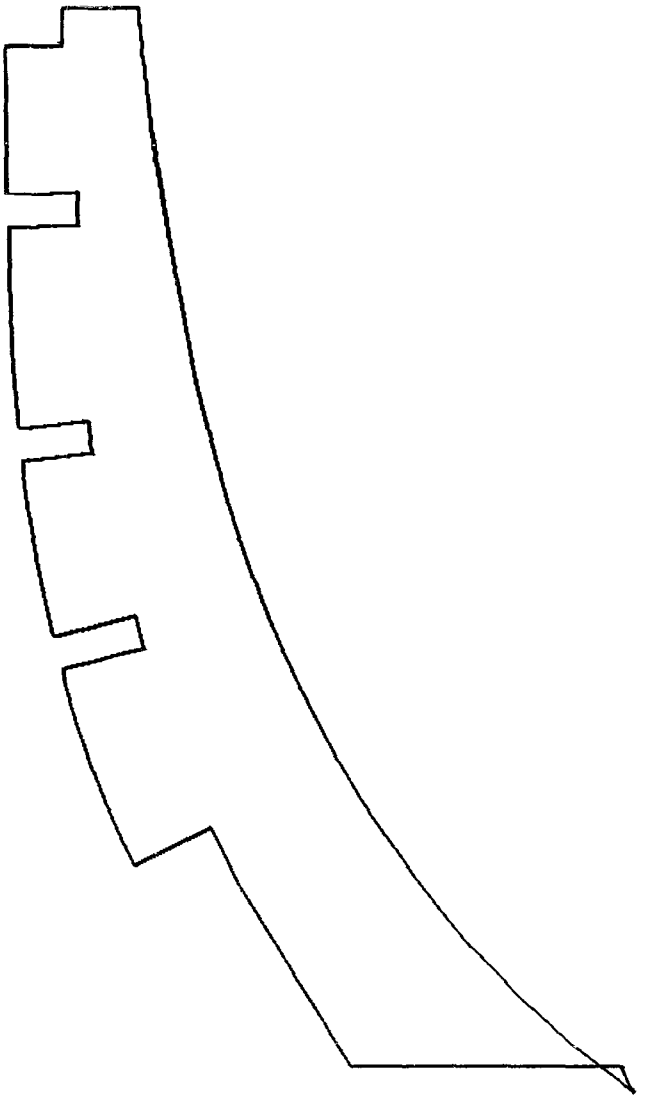


Fig. II-4 Typical Plot of Part Produced on Cal-Comp Plotter

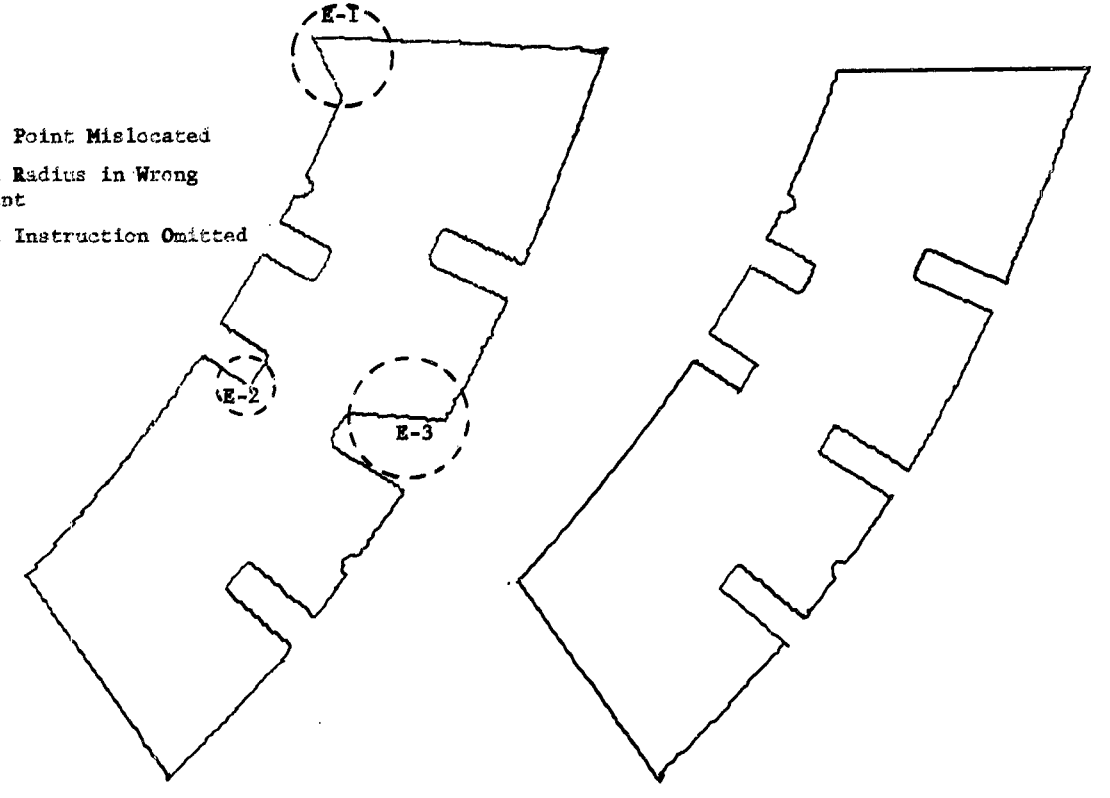


Fig. II-5 Plot of Part Containing Programming Errors, and Plot with Errors Corrected

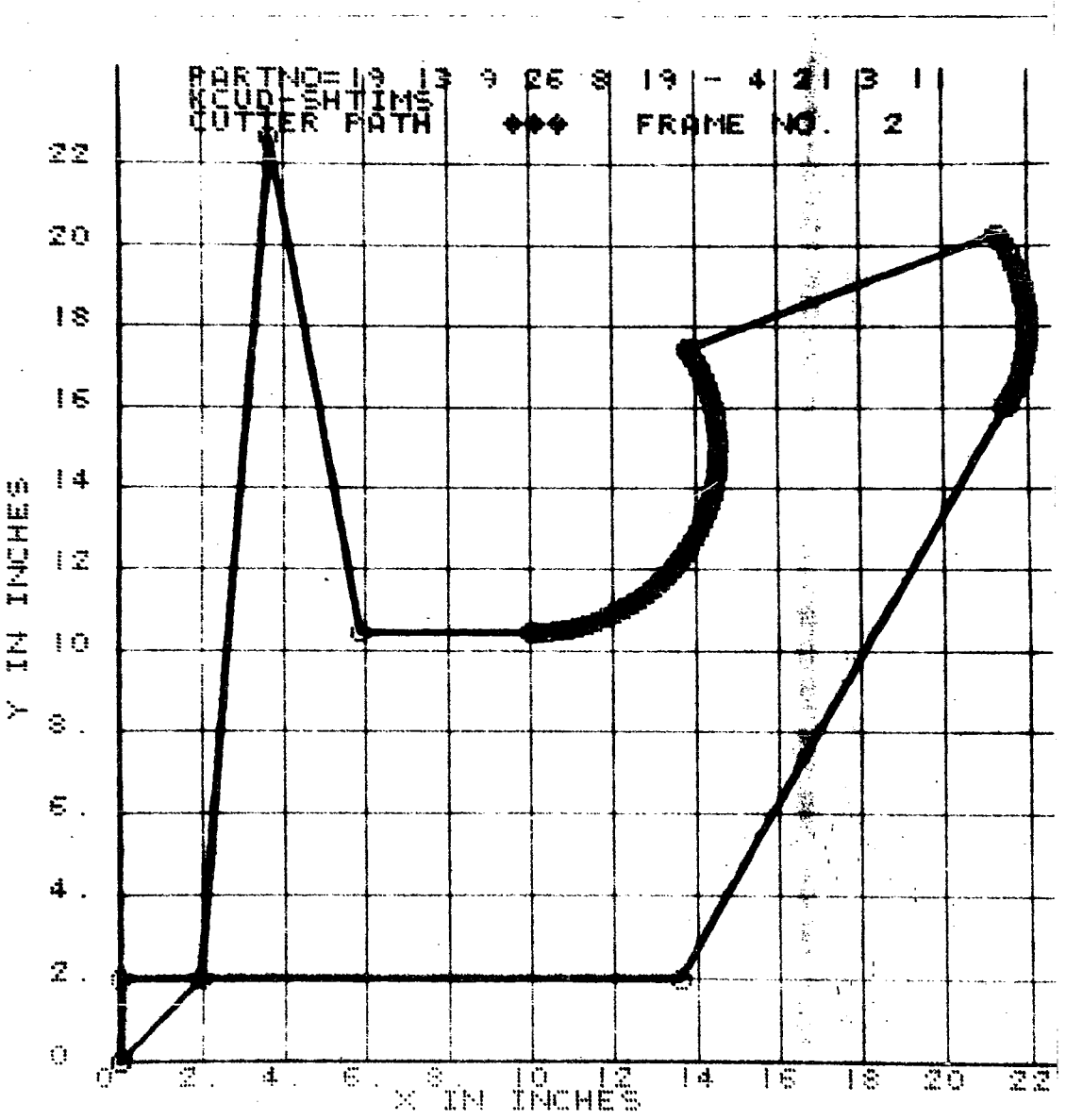


Fig. II-6 Typical Part Plot from a General Dynamics Plotter, Using APT Language

THE NESTING PROCEDURE

The nesting procedure developed employs the plot of the parts which were produced for checking purposes in the previous step, and the punched cards which were used to generate the plots.

The procedure used is as follows:

a. The plotted, scaled parts are cut out around their periphery with scissors. This need not be a precise operation.

b. These plots are then manually nested on graph paper on which the plate dimensions have been outlined. This operation is shown in Fig. II-7.

c. For each part, the X and Y coordinates of the location of any two widely separated known points on each part, such as corners, are read from the graph and recorded on a form such as is shown in Fig. II-8.

d. This information for each plate is then punched into cards, one card for each part.

e. These cards are then merged with the cards which were used in the original plotting operation.

f. The cards are then re-run in the computer, where the original dimensions are rotated and translated to their new locations on the plate, and then post processed to produce a tape for the burning operation.

g. Using either cards or tape, a final sketch can be drawn on the plotter to show actual sequence of motions of the burning machine. Figure II-9 shows such a sketch.

The program and operating instructions for the post processor (which includes the nesting routine) for the AUTOMAP language and General Electric Co. Mark Century director, are given in Appendix E.

The IBM-1620 program and operating instructions for plotting the GE Mark Century tape on a California Computer Products Co. plotter is given in Appendix F.

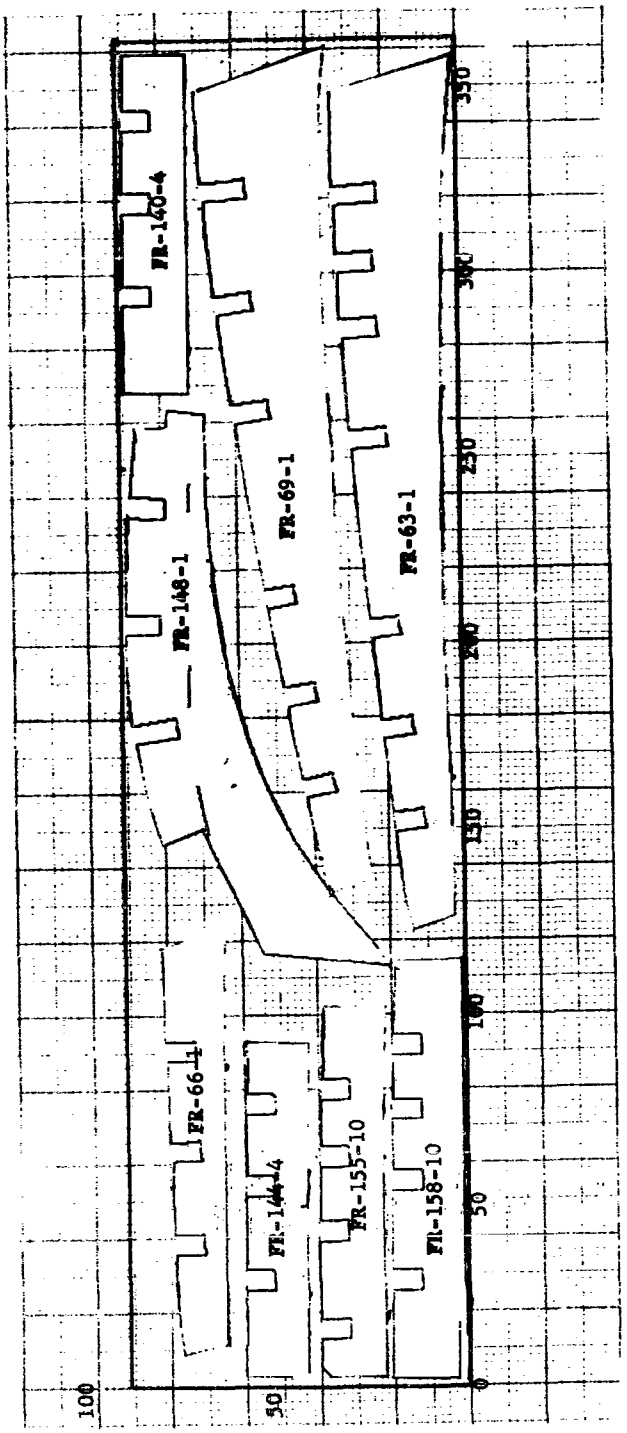


Fig. II-7 Plots of Parts Manually Nested on Graph Paper on which Plate Dimensions are Outlined

TRANSFORMATION COORDINATES

$\bar{1}8$	SCALE	X_1	Y_1	X_2	Y_2	X_{1t}	Y_{1t}	X_{2t}	±	Y_{2t}	TITLE
1,2	5 10	13 17	21 25	29 33	37 41	45 49	53 57	61 65	67	69 73	75
$\bar{1}8$	001060	32256	26550	32269	32856	09200	01900		-	02000	158-10
$\bar{1}8$	001000	17706	31919	23806	32631	17350	08600			08700	148-1
$\bar{1}8$	001000	32419	26469	32412	32881	08000	03900		-	04000	155-10
$\bar{1}8$	001000	32744	28269	32662	32994	07600	05900		-	06000	144-4
$\bar{1}8$	001000	28394	35663	27531	30519	03800	07800			08000	66-1
$\bar{1}8$	001000	32719	33031	32788	28294	29300	08900			08900	140-4
$\bar{1}8$	001000	35412	28856 $\bar{5}$	19363	26131 $\bar{5}$	16000	04200			06900	69-1
$\bar{1}8$	001000	35925	27881 $\bar{5}$	19381	24238 $\bar{5}$	15200	01700			03300	63-1

CS 5-22 — DRAWING NO.
DLG-33 — HULL NO.
R.W. FEENY — PROGRAMMER
10-28-62 — DATE

INSTRUCTIONS:
COL 2, $\bar{8}$ IF PART INVERTED.
COL 67,- IF NEAR INTERSEPT. REQ.
COL 69,- IF Y_{2t} IS OMITTED.

Fig. II-8 Form Used for Nesting: Recording of Information for Each Plate Which Will be Punched Into Cards

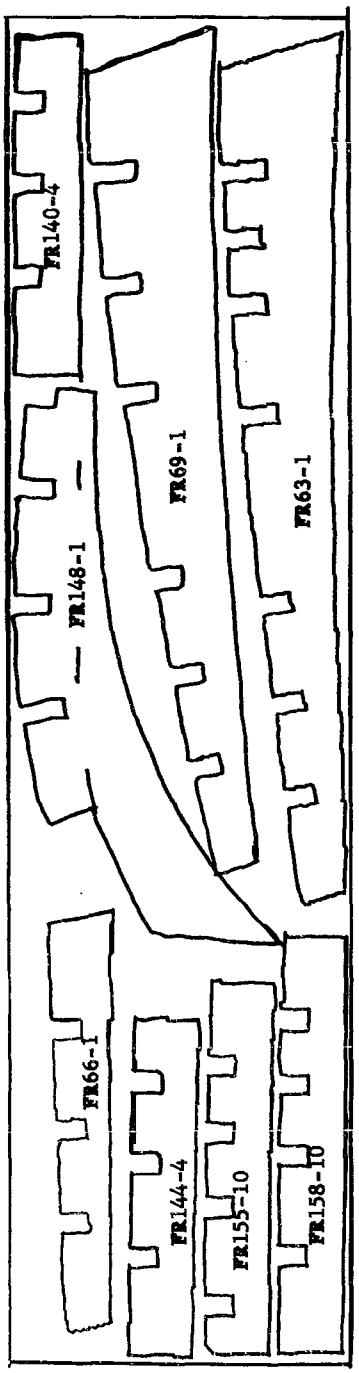


Fig. II-9 Final Sketch Drawn on the Plotter to Show Actual Sequence of Motions of Burning Machine

ERROR CORRECTION

During computer operation, errors may appear which were caused by incorrect part programming. In many instances these errors can be corrected without repeating previously-performed operations. Appendix C shows several methods for correcting such errors at the various phases of computer operation.

Through short-cut methods of correcting errors, significant savings in programming time can result.

Section III

REFERENCES*

1. Todd Shipyards Corporation, Mathematical Ship Lofting, Part 1. Theory, Technical Report 1.0.0-1, Mar 1963 (Vol 2 of Final Report, Contract NObs-4427

2. Todd Shipyards Corporation, A Programming System for Numerically Controlled Flame Cutting of Ships' Parts, by R. W. Feeny and T. G. Smith, Contract NObs-4427, Technical Report 5.4.0, 10 Sep 1962

3. IBM Corporation, Data Processing Division, AUTOMAP II - A 1620 Program for Numerical Control of Machine Tools, 14 Jan 1963

*References 1 and 2 were submitted to BuShips on the dates they were published. Reference 3 is submitted to BuShips along with this publication. Other readers may obtain copies of Ref. 3 direct from IBM Corporation.

Appendix A

MANUAL PARTS PROGRAM

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Appendix A

MANUAL PARTS PROGRAM

When a part consists mainly of circular arcs and straight lines which are parallel to the axis systems, it may be more economical to prepare the control tape without the aid of a computer.

SAMPLE PROGRAM

In programming the part shown in Fig. A-1, the first step was to make the calculations shown on Page A-3 to locate points 1a and 2a on the centerline path of the torch. After these points were located, the part was programmed (Fig. A-2). The time required for a proficient programmer in this operation is about the same as for a computer programming.

The information was then punched into tape using a tape-punching typewriter which also reproduced the programmed information onto the program sheet under the handwritten entries. This function provides a way to check the accuracy of the tape-punching process.

The cost of preparing this tape was:

Calculation	1/4 hr. @ $4.00	=	$1.00
Programming	1/2 hr. @ 4.00	=	2.00
Tape punching	1/4 hr. @ 2.40	=	.60
Total			$3.60

This amount is roughly half of what the cost would be to prepare this tape by computer. As the parts increase in complexity, however, this ratio is quickly reversed.

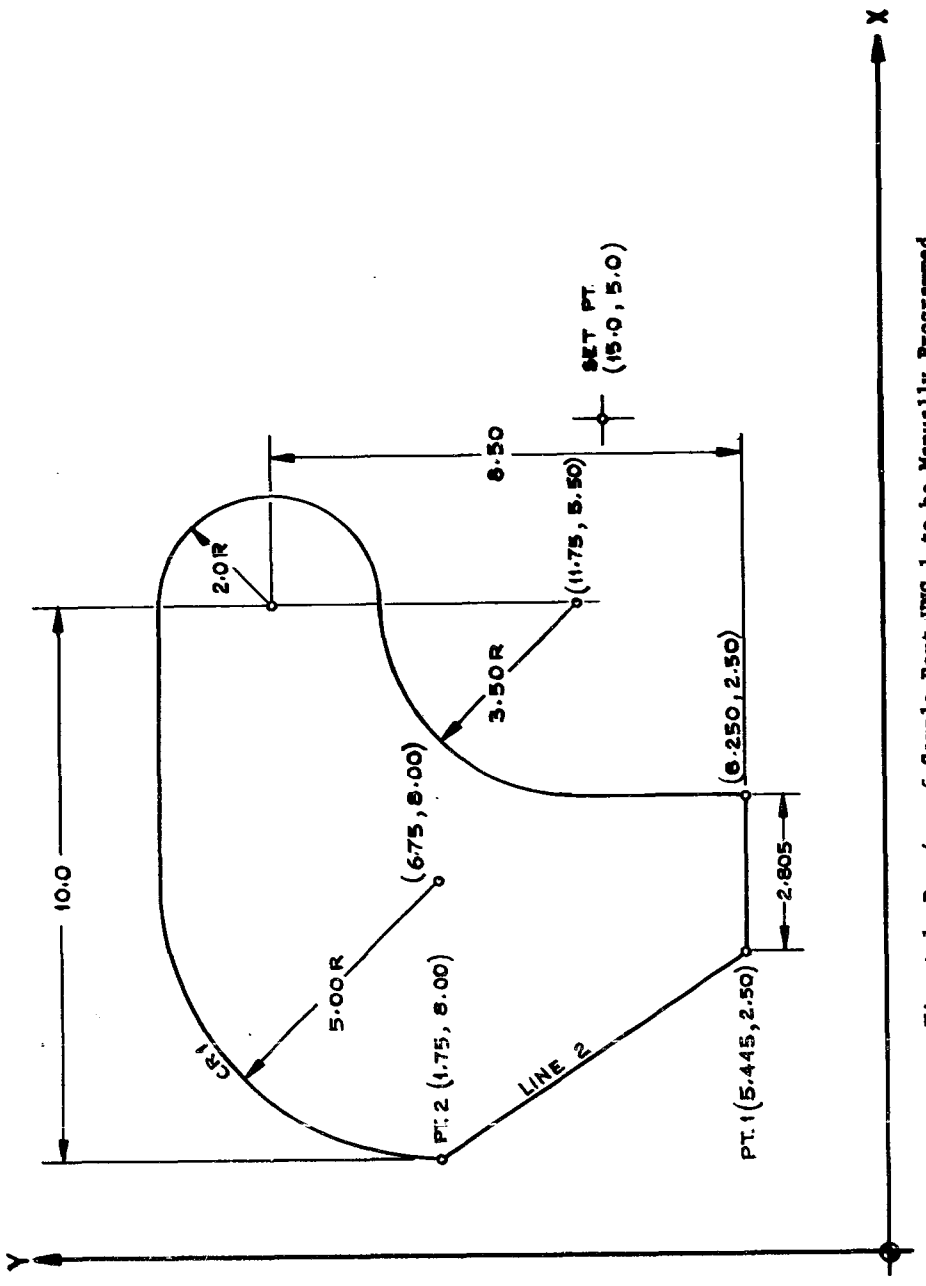
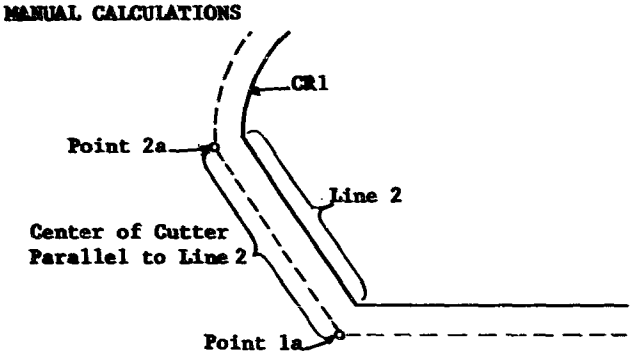


Fig. A-1 Drawing of Sample Part UNC-1 to be Manually Programmed

MANUAL CALCULATIONS **Time: 15 minutes**



LINE 2 (1.75 , 8.00 , 5.445 , 2.50)

Equation - Line 2

$$\text{Slope} = \frac{3.695}{5.50} = -.67182$$

$$X = 0.67182\ Y + 7.12455$$

Equation - Circle CR1

$$5^2 = (X-6.75)^2 + (Y-8.00)^2$$

Equation of Center of Cutter Parallel to Line 2

Tool Radius = 1.0

$$X = -.67182\ Y + 5.9198$$

Point 1a

$$Y = 1.50$$
$$X = 4.9121$$

Equation of Centerline of Cutter Around Arc CR1

$$6^2 = (X-6.75)^2 + (Y-8.00)^2$$

Intersection

$$36 - Y^2 + 16.0\ Y - 64.00 = (-.67182\ Y + 5.9198 - 6.75)^2$$

$$-Y^2 + 16.0\ Y - 28.00 = .45134\ Y^2 = 1.1155\ Y + .68923$$

$$1.45134Y^2 - 14.8845Y + 28.68923 = 0$$

$$Y^2 - 10.25570Y + 19.7674 = 0$$

$$Y = \frac{-b + \sqrt{b^2 - 4ac}}{2} \qquad \frac{5.1098}{\sqrt{26.1098}}$$

Point 2a

$$Y = 7.6828$$
$$X = 0.7583$$

AIR REDUCTION TAPE—O—GRAPH
NUMERICAL CONTROL MANUSCRIPT

PART NUMBER AIRCO TEST
PART NAME UNC-1
MATERIAL 20.4 MS
TIP NO. and STYLE 450

PAGE 1 OF 1
DATE 3 JAN 63
PROGRAMMER R.W. FERNY

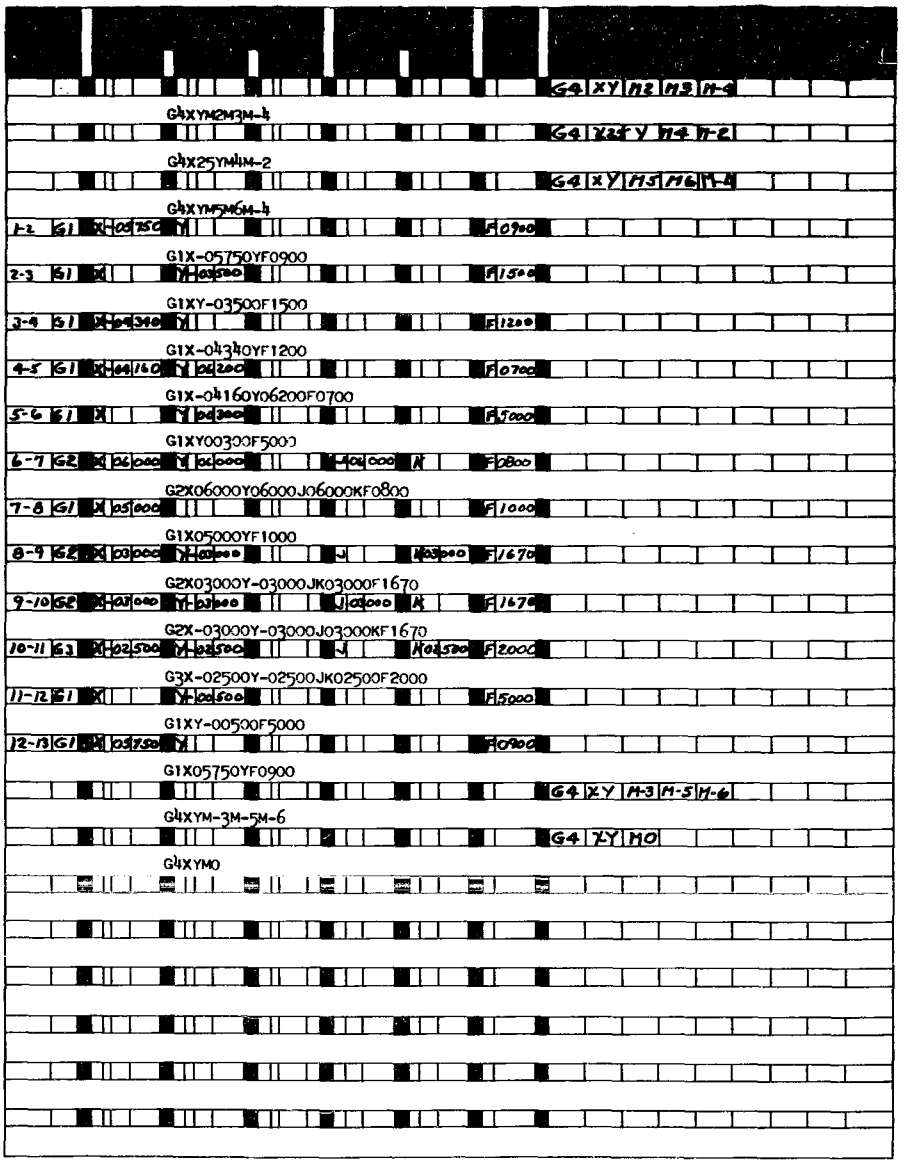


Fig. A-2 Manual Programming of Sample Part Showing (1) Handwritten Entries and (2) Programmed Information Typed Thereon Using a Tape-Punching Typewriter

Appendix B

SAMPLE COMPUTER PARTS PROGRAMS AND MACRO INSTRUCTIONS

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Appendix B

SAMPLE COMPUTER PARTS PROGRAMS AND MACRO INSTRUCTIONS

INTRODUCTION

Part 1 of this Appendix is a computer parts program written for numerically controlled flame cutting of a floor at Frame 52 of the DLG-33. A sketch of this part is shown in Fig. B-1. The program employs only those basic capabilities which were written into AUTOMAP (or AUTOMAP I). This part required 148 instructions to program, 96 of which were needed to define the periphery, and 52 to define the cutouts. In addition, it was necessary to manually segment the curves to obtain the data for the parts program.

Part 2 gives a parts program for the same DLG-33 floor, as described in Part 1, employing macro capability. Only 48 programming instructions were required to described the part, 42 of which defined the periphery, and 5 the cutouts. The program still required the manual segmentation of the curves.

Part 3 of this Appendix gives 10 macros, written to employ the Macro capability of AUTOMAP II. These macros are pre-punched into cards and filed for use as required. They need never be reprogrammed and can be called into a parts program by a single statement starting with "Domac." As a programmer gains experience, he can prepare other macro instructions to reduce programming time.

Part 4 is another parts program for DLG floor Frame 52, but in this program the TABCYL and general cubic capabilities of AUTOMAP are employed to define the curves. The hull contours have been previously described by cubic equations so that the coefficients of those equations can be

used in the program. The inner hull contour is defined by a tab cylinder through the known stringer intersections. In this program, only 25 instructions were required to define the part.

In Part 5, a MACRO instruction for a full floor is used to define floor frames 46 through 52. The parts programs for each floor now requires only one instruction and the necessary data points and equations to define it. At this time, AUTOMAP does not have the capability to accept MACRO's this large. However, the potential economies to be derived from such capability is apparent in these programs.

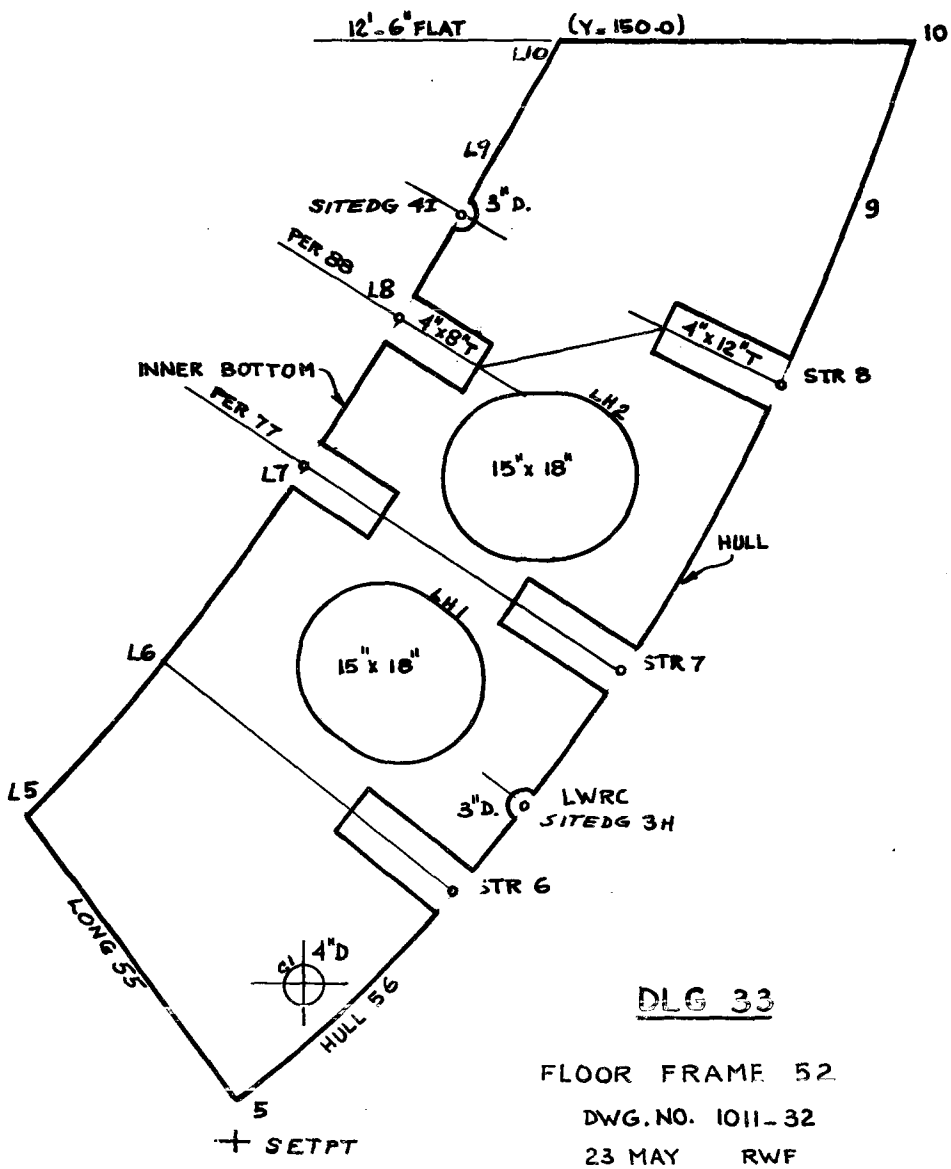


Fig. B-1 Sketch of Floor Frame 52, DLG-33

PARTS PROGRAM EMPLOYING ONLY BASIC AUTOMAP CAPABILITIES

(i.e., No Macros or TabCyl)

```
REMARK  HULL CONTOUR
        FROM/128.0,53.0,0.0
        TLRAD/0.050
        TOLER/0.030
        FEDRAT/20.0
HULL5   =LINE/127.74,53.5,132.39,57.87
        G4XYM2M3M-4
        G4X25YM4M-2
        G4XYM5M6M-4
        INDIR,VECTOR/-1.0,1.0,0.0
        GOTO/HULL5
        GORGT/HULL5
        GOLFT,LINE/132.39,57.87,137.37,62.86
        GOLFT,LINE/137.37,62.86,142.07,67.90
STR6    =POINT/146.50,73.0,0.0
        GOLFT,LINE/142.07,67.90,STR6
CL6     =LINE/STR6,ATANGL,-40.0
TAN6    =LINE/STR6,PERPTO,CL6
LWR6    =GOLFT,LINE/PARLEL,CL6,YSMALL,2.5
INBD6   =LINE/PARLEL,TAN6,XSMALL,12.0
UPR6    =LINE/PARLEL,CL6,YLARGE,2.5
        GOFWD,CIRCLE/LWR6,YLARGE,INBD6,XLARGE,RADIUS,0.5
        GOFWD/INBD6
        GOFWD,CIRCLE/UPR6,YSMALL,INBD6,XLARGE,RADIUS,0.5
        GOFWD,UPR6
        GOLFT,LINE/STR6,150.72,78.23
LWRC    =POINT/153.12,81.50,0.0
        GOLFT,LINE/150.72,78.23,LWRC
        FAR,GOLFT,CIRCLE/CENTER,LWRC,RADIUS,1.5
        GOLFT,LINE/LWRC,154.71,83.55
        GOLFT,LINE/154.71,83.55,158.51,89.01
STR7    =POINT/161.42,93.50,0.0
        GOLFT,LINE/158.51,89.01,STR7
CL7     =LINE/STR7,ATANGL,-32.1
TAN7    =LINE/STR7,PERPTO,CL7
LWR7    =GOLFT,LINE/PARLEL,CL7,YSMALL,2.5
INBD7   =LINE/PARLEL,TAN7,XSMALL,12.0
UPR7    =LINE/PARLEL,CL7,YLARGE,2.5
        GOFWD,CIRCLE/LWR7,YLARGE,INBD7,XLARGE,RADIUS,0.5
        GOFWD/INBD7
        GOFWD,CIRCLE/UPR7,YSMALL,INBD7,XLARGE,RADIUS,0.5
        GOFWD/UPR7
        GOLFT,LINE/162.13,94.65,165.61,100.51
        GOLFT,LINE/165.61,100.51,168.97,106.66
        GOLFT,LINE/168.97,106.66,172.27,113.19
STR8    =POINT/175.0,119.0,0.0
        GOLFT,LINE/172.27,113.19,STR8
CL8     =LINE/STR8,ATANGL,=24.4
TAN8    =LINE/STR8,PERPTO,CL8
LWR8    =GOLFT,LINE/PARLEL,CL8,YSMALL,2.5
INBD8   =LINE/PARLEL,TAN8,XSMALL,12.0
UPR8    =LINE/PARLEL,CL8,YLARGE,2.5
        GOFWD,CIRCLE/LWR8,YLARGE,INBD8,XLARGE,RADIUS,0.5
        GOFWD/INBD8
        GOFWD,CIRCLE/UPR8,YSMALL,INBD8,XLARGE,RADIUS,0.5
        GOFWD/UPR8
        GOLFT,LINE/175.56,120.26,178.95,128.15
        GOLFT,LINE/178.95,128.15,182.72,137.57
        GOLFT,LINE/182.72,137.57,187.40,150.00
        GOLFT,LINE/153.75,150.0,187.4,150.0
```

```
REMARK   INNERBOTTOM CONTOUR
         GOLFT,LINE/153.75,150.0,151.61,144.0
         GORGT,LINE/151.61,144.0,149.09,138.0
         GORGT,LINE/149.09,138.0,146.23,132.0
         FAR,GOLFT,CIRCLE/146.23,132.0,1.5
         GOLFT,LINE/146.23,132.0,142.50,125.0
PER88    =LINE/142.50,125.0,ATANGL,-29.4
TA88     =LINE/142.50,125.0,PERPTO,PER88
INB88    =LINE/PARLEL,TA88 ,XLARGE,8.0
UP88     =GOLFT,LINE/PARLEL,PER88,YLARGE,2.5
          GOFWD,CIRCLE/UP88,YSMALL,INB88,XSMALL,RADIUS,0.50
          GOFWD/INB88
LW88     =LINE/PARLEL,PER88,YSMALL,2.5
          GOFWD,CIRCLE/LW88,YLARGE,INB88,XSMALL,RADIUS,0.50
          GOFWD/LW88
          GOLFT,LINE/142.5,125.0,139.58,120.0
          GORGT,LINE/139.58,120.0,135.82,114.0
          GORGT,LINE/135.82,114.0,134.25,111.62
PER77    =LINE/134.25,111.62,ATANGL,-33.8
TA77     =LINE/134.25,111.62,PERPTO,PER77
INB77    =LINE/PARLEL,TA77,XLARGE,8.0
UP77     =GOLFT,LINE/PARLEL,PER77,YLARGE,2.5
          GOFWD,CIRCLE/UP77,YSMALL,INB77,XSMALL,RADIUS,0.50
          GOFWD/INB77
LW77     =LINE/PARLEL,PER77,YSMALL,2.5
          GOFWD,CIRCLE/LW77,YLARGE,INB77,XSMALL,RADIUS,0.50
          GOFWD/LW77
          GOLFT,LINE/134.25,111.62,131.77,108.0
          GORGT,LINE/131.77,108.0,127.44,102.0
          GORGT,LINE/127.44,102.0,122.80,96.0
          GORGT,LINE/122.80,96.0,117.86,90.0
          GORGT,LINE/117.86,90.0,112.59,84.0
          GORGT,LINE/112.59,84.0,109.12,80.25
          GOLFT,LINE/109.12,80.25,127.88,53.50
          GOPAST/HULL5
          G4XYM-6M-5M-3
          GO TO /128.0,53.0,0.0
          END
REMARK    LIGHTENING HOLES
          FROM/128.0,52.0,0.0
          TLRAD/0.050
          TOLER/0.010
          FEDRAT/100.0
          GOTO/134.0,65.46,0.0
REMARK   LOWER CIRCULAR CUTOUT
          G4XYM2M3M-4
          G4X25YM4M-2
          G4XYM5M6M-4
CIRC1    =CIRCLE/134.0,65.48,2.0
HORIZ1   =LINE/134.0,65.48,ATANGL,0.0
          FEDRAT/20.0
          INDIR,VECTOR/0.0,1.0,0.0
          GOPAST/HORIZ1
          GOLFT/HORIZ1
          GOTO/CIRC1
          FAR,GORGT/CIRC1
          GOPAST/HORIZ1
          G4XYM-5M-6M-3
```

```
REMARK   CENTER LIGHTENING HOLE
         FEDRAT/100.0
         GOTO/135.0,92.5,0.0
CLLWR2 =LINE/141.0,92.5,ATANGL,-36.0
PRP2   =LINE/141.0,92.5,PERPTO,CLLWR2
LCTR2  =LINE/PARLEL,PRP2,XSMALL,1.5
RCTR2  =LINE/PARLEL,PRP2,XLARGE,1.5
UPPT2  =POINT/INTOF/CLLWR2,LCTR2
LWPT2  =POINT/INTOF/CLLWR2,RCTR2
CIRUP2 =CIRCLE/CENTER,UPPT2,RADIUS,7.5
         G4XYM2M3M-4
         G4X25YM4M-2
         G4XYM5M6M-4
         FEDRAT/20.0
         INDIR,VECTOR/-1.0,0.0,0.0
         GOTO/CIRUP2
         GORGT/CIRUP2
         GOFWD,LINE/PARLEL,CLLWR2,YLARGE,7.5
         GOFWD,CIRCLE/CENTER,LWPT2,RADIUS,7.5
         GOFWD,LINE/PARLEL,CLLWR2,YSMALL,7.5
         GOFWD/CIRUP2
         GOPAST,LINE/0.0,91.75,ATANGL,0.0
         G4XYM-5M-6M-3
REMARK   UPPER LIGHTENING HOLE
R30    =CIRCLE/154.0,111.0,7.5
R31    =CIRCLE/157.0,111.0,7.5
HORIZ3 =LINE/154.0,111.0,ATANGL,0.0
VERT3  =LINE/155.0,111.0,PERPTO,HORIZ3
UPR3   =LINE/155.5,118.5,ATANGL,0.0
LWR3   =LINE/155.5,103.5,ATANGL,0.0
         FEDRAT/100.0
         GOTO/154.5,106.0,0.0
         G4XYM2M3M-4
         G4X25YM4M-2
         G4XYM5M6M-4
         FEDRAT/20.0
         INDIR,VECTOR/0.0,-1.0,0.0
         GOTO/LWR3
         GORGT/LWR3
         GOFWD/R30
         GOFWD/UPR3
         GOFWD/R31
         GOFWD/LWR3,PAST,VERT3
         G4XYM-5M-6M-3
         FEDRAT/100.0
         GOTO/128.0,52.0,0.0
         FINI
```

This program, employing only basic AUTOMAP capabilities, required 148 instructior 96 to define the periphery, 52 to define cutouts

PARTS PROGRAM EMPLOYING AUTOMAP MACROS

```
REMARK  HULL CONTOUR

START  =DOMAC/128.0,53.0,0.0,0.050,0.010,20.0
HULL5  =LINE/127.74,53.5,132.39,57.87
        INDIR,VECTOR/-1.0,1.0,0.0
        GOTO/HULL5
        GORGT/HULL5
        GOLFT,LINE/132.39,57.87,137.37,62.86
        GOLFT,LINE/137.37,62.86,142.07,67.90
        GOLFT,LINE/142.07,67.90,146.50,73.0
LFTCT2 =DOMAC/146.5,73.0,-40.0,12.0,2.5,0.5
        GOLFT,LINE/146.50,73.0,150.72,78.23
        GOLFT,LINE/150.72,78.23,153.12,81.50
        FAR,GOLFT,CIRCLE/153.12,81.50,1.5
        GOLFT,LINE/153.12,81.50,154.71,83.55
        GOLFT,LINE/154.71,83.55,158.51,89.01
        GOLFT,LINE/158.51,89.01,161.42,93.50
LFTCT2 =DOMAC/161.42,93.5,-32.1,12.0,2.50,0.50
        GOLFT,LINE/162.13,94.65,165.61,100.51
        GOLFT,LINE/165.61,100.51,168.97,106.66
        GOLFT,LINE/168.97,106.66,172.27,113.19
        GOLFT,LINE/172.27,113.19,175.0,119.0
LFTCT2 =DOMAC/175.0,119.0,-24.4,12.0,2.5,0.50
        GOLFT,LINE/175.56,120.26,178.95,128.15
        GOLFT,LINE/178.95,128.15,182.72,137.57
        GOLFT,LINE/182.72,137.57,187.40,150.00
        GOLFT,LINE/0.0,150.0,ATANGL,0.0
REMARK  INNERBOTTOM CONTOUR

        GOLFT,LINE/153.75,150.0,151.61,144.0
        GORGT,LINE/151.61,144.0,149.09,138.0
        GORGT,LINE/149.09,138.0,146.23,132.0
        FAR,GOLFT,CIRCLE/146.23,132.0,1.5
        GOLFT,LINE/146.23,132.0,142.50,125.0
LFTCT4 =DOMAC/142.50,125.00,-30.0,8.00,2.50,0.50
        GOLFT,LINE/142.5,125.0,139.58,120.0
        GORGT,LINE/139.58,120.0,135.82,114.0
        GORGT,LINE/135.82,114.0,134.25,111.62
LFTCT4 =DOMAC/134.25,111.62,-33.8,8.00,2.50,0.50
        GOLFT,LINE/134.25,111.62,131.77,108.0
        GORGT,LINE/131.77,108.0,127.44,102.0
        GORGT,LINE/127.44,102.0,122.80,96.0
        GORGT,LINE/122.80,96.0,117.86,90.0
        GORGT,LINE/117.86,90.0,112.59,84.0
        GORGT,LINE/112.59,84.0,109.12,80.25
        GOLFT,LINE/109.12,80.25,127.88,53.50
END    =DOMAC/128.0,53.0,0.0,HULL5

REMARK   LIGHTENING HOLES
START  =DOMAC/128.0,53.0,0.0,0.050,0.010,20.0
CTCIR1 =DOMAC/134.0,65.48,0.0,2.0,0.0
LTHOL3 =DOMAC/133.0,92.5,-36.0,7.5,1.5,1.0
LTHOL3 =DOMAC/154.0,111.0,0.0,7.5,1.5,1.0
        FINI
```

This program, employing six MACROS, required only 48 programming instructions: 42 which defined the periphery, and 5 the cutouts.

MACROS

INSTRUCTIONS FOR USE

1. MACRO instructions must be loaded in card reader before parts program deck

CTOUT = DOMAC/"XCOORD" , "YCOORD" , "ROTATION ANGLE",

(This to be followed by the variables A, B, C, D)

All MACROS must be given location and rotation angle.

Rotation angle may not exceed $\pm$ 89.5^{o}

MACRO FOR START

```
START  =MACRO/A,B,C
SETPT  =POINT/0.0,0.0,0.0
        FROM/SETPT
        TLRAD/A
        TOLER/B
        FEDRAT/C
        G4XYM2M3M-4                    S
        G4X25YM4M-2                    S
        G4XYM5M6M-4                    S
        TERMAC
```

Note: This MACRO is a substitute for seven normal instructions which are used to describe the starting point, tool radius, tolerance, feedrate, and the auxiliary functions required for torch operation.

Example

START = DOMAC/128.0,53.0,0,0,.040.030,20.0

Explanation

From a point located at Buttock Line 128 and Waterline 53, no rotation is involved. The Radius of the torch is .040, the tolerance required is .030, and the feedrate is to be 20 inches per minute.

MACRO FOR END

```
END    =MACRO/A
P1     =POINT/0.0,0.0,0.0
        GOPAST/A
        G4XYM-3M-5M-6                  S
        GOTO/P1
        END
        TERMAC
```

Note: This MACRO is a substitute for four normal instructions which are used to describe the closing cut, the torch off operation, and the point to which the torch must return to end the sequence.

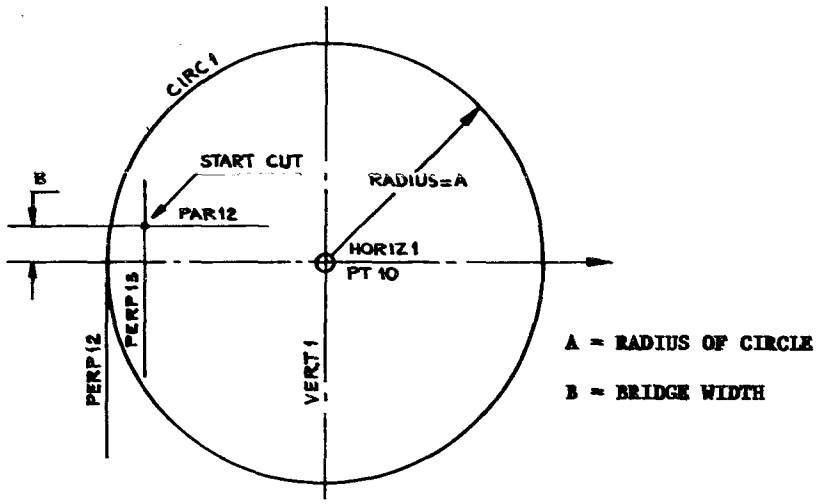
Example:

END = DOMAC/128.0,53.0,0.0,HULL5

Explanation

Torch should return to a point located at buttock line 128 and Waterline 53. The flame will go out after torch passes the contour defined as Hull 5.

Fig. B-2 MACRO FOR CIRCULAR CUTOUTS




```
CTCIR1 =MACRO/A,B
PT10   =POINT/0.0,0.0,0.0
PT11   =POINT/1.0,0.0,0.0
CIRC1  =CIRCLE/CENTER,PT10,RADIUS,A
HORIZ1 =LINE/PT10,PT11
VERT1  =LINE/PT10,PERPTO,HORIZ1
PERP12 =LINE/PARLEL,VERT1,XSMALL,A
PAR12  =LINE/PARLEL,HORIZ1,YLARGE,B
PERP13 =LINE/PARLEL,PERP12,XLARGE,0.75
        FEDRAT/100.0
        DNTCUT
        GOTO/PT10
        INDIR,VECTOR/-1.0,0.0,0.0
        GOTO/PERP13
        GORGT/PERP13
        CUT
        GOPAST/PAR12
        FEDRAT/20.0
        G4XYM2M3M-4                    S
        G4X25YM4M-2                    S
        G4XYM5M6M-4                    S
        GOLFT/PAR12
        FAR,GORGT/CIRC1
        GOPAST/HORIZ1
        G4XYM-5M-6M-3                  S
        TERMAC
```

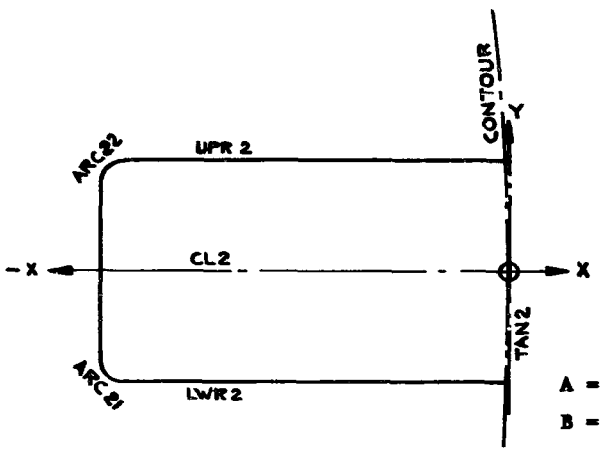
EXAMPLE OF USE

```
CTCIR1    = DOMAC/134.0,65.48,0.0,2.0,0.0001
```

EXPLANATION

Cutout full circle whose center is at Btk. 134.0 and WL 65.48 No. rotation is involved, the radius of circle is 2.00" and no bridge is required.

B-3 MACRO FOR STRINGER CUTOUTS



A = LENGTH

B = $\frac{\text{WIDTH}}{2}$

C = CORNER RADIUS

D = CONTOUR

```
LFTCT2 =MACRO/A,B,C,D
P21    =POINT /0.0,0.0,0.0
P22    =POINT /1.0,0.0,0.0
CL2    =LINE/P21,P22
TAN2   =LINE/P21,PERPTO,CL2
LWR2   =LINE/PARLEL,CL2,YSMALL,B
UPR2   =LINE/PARLEL,CL2,YLARGE,B
INBD2  =LINE/PARLEL,TAN2,XSMALL,A
ARC21  =CIRCLE/LWR2,YLARGE,INBD2,XLARGE,RADIUS,C
ARC22  =CIRCLE/UPR2,YSMALL,INBD2,XLARGE,RADIUS,C
        GOLFT/LWR2
        GOFWD/ARC21
        GOFWD/INBD2
        GOFWD/ARC22
        GOFWD/UPR2
        GOLFT/D
        TERMAC
```

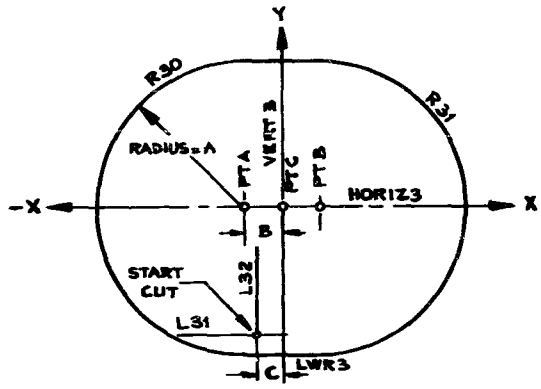
EXAMPLE OF USE

```
LFTCT2   = DOMAC/140.0,362.54,-28.0,8.0,2.5,0.50
```

EXPLANATION

Cut stringer cutout located at BL 140.0 and WL 362.54 at an angle The slope of the cutout is -28° with an 8" length, and half width of 2.5" , and corner radius of .50"

Fig. B-4 MACRO FOR LIGHTENING HOLES



A = RADIUS
B = RADIUS OFFSET
C = BRIDGE WIDTH

```
LTHOL3 =MACRO/A,B,C
PTA    =POINT/-B,0.0,0.0
PTB    =POINT/B,0.0,0.0
PTC    =POINT/0.0,0.0,0.0
R30    =CIRCLE/CENTER,PTA,RADIUS,A
R31    =CIRCLE/CENTER,PTB,RADIUS,A
HORIZ3 =LINE/PTA,PTB
VERT3  =LINE/PTC,PERPTO,HORIZ3
UPR3   =LINE/PARLEL,HORIZ3,YLARGE,A
LWR3   =LINE/PARLEL,HORIZ3,YSMALL,A
L31    =LINE/PARLEL,LWR3,YLARGE,0.25
L32    =LINE/PARLEL,VERT3,XSMALL,C
        DNTCUT
        FEDRAT/100.0
        GO TO/PTC
        INDIR,VECTOR/0.0,-1.0,0.0
        GO TO/L31
        CUT
        GO RGT/L31
        FEDRAT/20.0
        G4XYM2M3M-4                    S
        G4X25YM4M-2                    S
        G4XYM5M6M-4                    S
        GO LFT/L32
        GORGT/LWR3
        GOFWD/R30
        GOFWD/UPR3
        GOFWD/R31
        GOFWD/LWR3,PAST,VERT3
        G4XYM-5M-6M-3                  S
        TERMAC
```

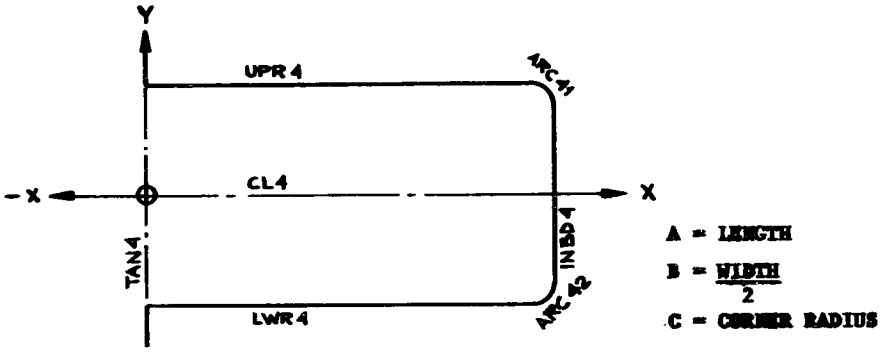
EXAMPLE OF USE

LTHOL3 = DOMAC/141.0,92.5,-36.0,7.5,1.5,1.0

EXPLANATION

Cutout lightening hole whose center is located at Btk. Line 141.0 and WL 92.5, rotated 36° clockwise, with 7.5" radius offset 1.5" and with a 1.0" bridge.

Fig. B-5 MACRO FOR STRINGER CUTOUTS




```
LFTCT4 =MACRO/A,B,C,D
P41    =POINT /0.0,0.0,0.0
P42    =POINT /1.0,0.0,0.0
CL4    =LINE/P41,P42
TAN4   =LINE/P41     ,PERPTO,CL4
UPR4   =LINE/PARLEL,CL4,YLARGE,B
LWR4   =LINE/PARLEL,CL4,YSMALL,B
INBD4  =LINE/PARLEL,TAN4,XLARGE,A
ARC41  =CIRCLE/UPR4,YSMALL,INBD4,XSMALL,RADIUS,C
ARC42  =CIRCLE/LWR4,YLARGE,INBD4,XSMALL,RADIUS,C
       GOLFT/UPR4
       GOFWD/ARC41
       GOFWD/INBD4
       GOFWD/ARC42
       GOFWD/LWR4
       GOLFT/D
       TERMAC
```

EXAMPLE OF USE

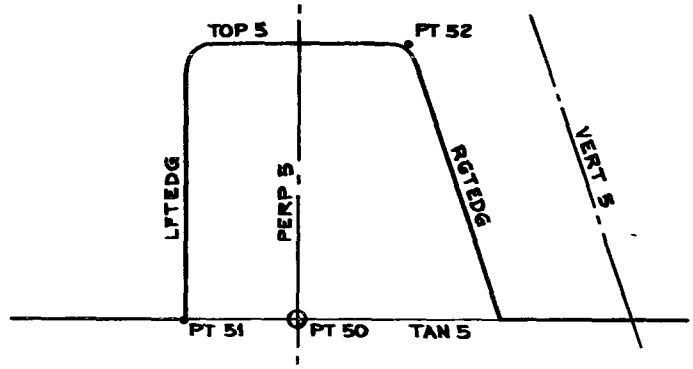
LFTCT4 = DOMAC/140.0,362.54,-28.0,8.0,2.5,0.50

EXPLANATION

Cut stringer cutout located at BL 140.0 and WL 362.54 at an angle. The slope of the cutout is -28° with an 8" length and half width of 2.5" and a corner radius of .50"

LFTCT 5

Fig. B-6 MACRO FOR STRINGER CUTOUTS



VERT 5 must be a vertical reference line previously described

A = Height of Cutout

B - 1/2 Width of Cutout

```
LFTCT5 =MACRO/A,B
PT50   =POINT/0.0,0.0,0.0
PT51   =POINT/-8,0.0,0.0
TAN5   =LINE/PT50,PT51
PERP5  =LINE/PT50,PERPTO,TAN5
TOP5   =LINE/PARLEL,TAN5,YLARGE,A
LFTEDG =LINE/PARLEL,PERP5,XSMALL,B
PT52   =POINT/B,A,0.0
RGTEDG =LINE/PT52,PARLEL,VERT5
        GOLFT/LFTEDG
        GOFWD,CIRCLE/LFTEDG,XLARGE,TOP5,YSMALL,RADIUS,0.20
        GOFWD/TOP5
        GOFWD,CIRCLE/TOP5,YSMALL,RGTEDG,XSMALL,RADIUS,0.20
        GOFWD/RGTEDG
        TERMAC
```

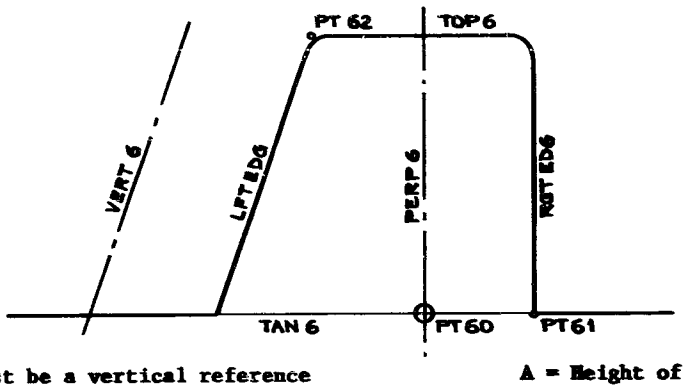
EXAMPLE

```
LFTCT5  = DOMAC/120.0,70.0,60.0,8.0,3.0
```

EXPLANATION

Locate a cutout centered about BL 120 and WL 70 at an angle of 60°. The cutout to be 8" deep and 3.0" each side of the center, with right edge parallel to a vertical reference line.

Fig. B-7 MACRO FOR STRINGER CUTOUTS



Vert 6 must be a vertical reference line previously described.

A = Height of Cutout

B = 1/2 Width of Cutout

```
LFTCT6 =MACRO/A,B
PT60   =POINT/0.0,0.0,0.0
PT61   =POINT/-B,0.0,0.0
TAN6   =LINE/PT60,PT61
PERP6  =LINE/PT60,PERPTO,TAN6
TOP6   =LINE/PARLEL,TAN6,YLARGE,A
PT62   =POINT/-B,A,0.0
LFTEDG =LINE/PT62,PARLEL,VERT6
RGTEDG =LINE/PARLEL,PERP6,XLARGE,B
        GOLFT/LFTEDG
        GOFWD,CIRCLE/LFTEDG,XLARGE,TOP6,YSMALL,RADIUS,0.50
        GOFWD/TOP6
        GOFWD,CIRCLE/TOP6,YSMALL,RGTEDG,XSMALL,RADIUS,0.50
        GOFWD/RGTEDG
        TERMAC
```

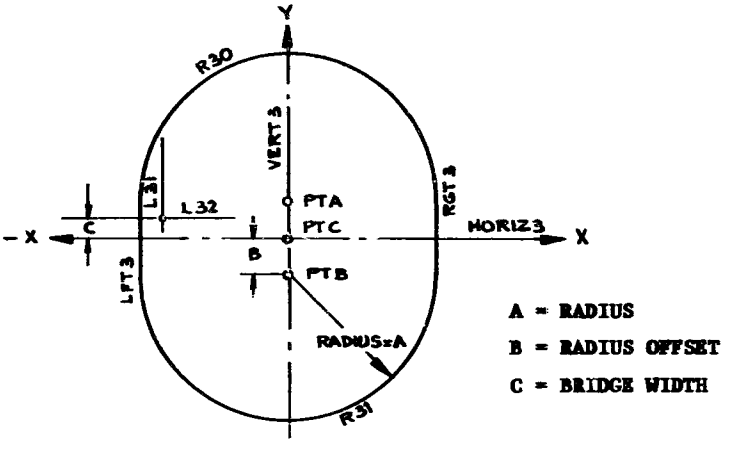
EXAMPLE

```
LFTCT6 = DOMAC/120.0,70.0,60.0,8.0,3.0
```

EXPLANATION

Locate a cutout centered about BL 120 and WL 70 at an angle of 60°. The cutout to be 8" deep and 3.0" each side of the center, with left edge parallel to a vertical reference line.

Fig. B-8 MACRO FOR LIGHTENING HOLE




```
LTHOLV =MACRO/ A, B, C
PTA    =POINT/ 0.0, B, 0.0
PTB    =POINT/ 0.0, -B, 0.0
PTC    =POINT/ 0.0, 0.0, 0.0
R30    =CIRCLE/ CENTER, PTA, RADIUS, A
R31    =CIRCLE/ CENTER, PTB, RADIUS,A
VERT3  =LINE/ PTA, PTB
HORIZ3 =LINE/ PTC, PERPTO, VERT3
RGT3   =LINE/ PARLEL, VERT3, XLARGE, A
LFT3   =LINE/ PARLEL, VERT3, XSMALL, A
L31    =LINE/ PARLEL, LFT3, XLARGE, 0.5
L32    =LINE/ PARLEL, HORIZ3, YLARGE, C
        DNTCUT
        FEDRAT/ 100.0
        GOTO/ PTC
        INDIR,VECTOR/ -1.0, 0.0, 0.0
        GOTO/ L31
        CUT
        GORGT/ L31
        FEDRAT/ 20.0
        G4XYM2M3M-4                          S
        G4X25YM4M-2                          S
        G4XYM5M6M-4                          S
        GOLFT/ L32
        GORGT/ LFT3
        GOFWD/ R30
        GOFWD/ RGT3
        GOFWD/ R31
        GOFWD/  LFT3, PAST, HORIZ3
        G4XYM-5M-6M-3
        TERMAC
```

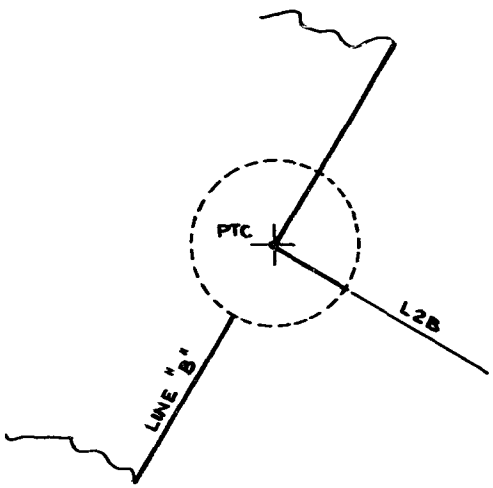
EXAMPLE

LTHOLV = DOMAC/100.0,50.0,0.0,7.5,1.5,1.0

EXPLANATION

Cutout lightening hole whoe center is located at BL 100, WL 50 and has a vertical axis. The cutout has two arcs of 7.5" radius located 1.5" above and below the horizontal reference and has a 1" bridge.

Fig. B-9 MACRO FOR BRIDGE




```
BRIDGE =MACRO/A,B
PTC    =POINT/0.0,0.0,0.0
        GORGT/CIRCLE,CENTER,PTC,RADIUS,A
        G4XYM-5
L2B    =LINE/PTC,PERPTO,B
        GOPAST/L2B
        G4X25YM4                              S
        G4XYM-4M5M6                           S
        GOLFT/L2B
        GORGT/B
        TERMAC
```

EXAMPLE

BRIDGE = DOMAC/106.0,42.0,0.0,1.0,HULL

EXPLANATION

Locate a tie (called a bridge) centered at BL 106 and WL 42, rotation not involved. The torch to go out 1" before reaching the point and then igniting outside of part. Return to hull and continue cut.

PARTS PROGRAM EMPLOYING TABCYL AND CUBIC COEFFICIENTS

```
REMARK  HULL CONTOUR
HULL5  =CUB/ 4668034712-4922214407 5129493563 5017251054,  48.0,   96.0,
             4593381301-4853097921 5113265133 5053314230,  96.0,  144.0,
             4581616139-4848015372 5112533246 5055753853, 144.0,  192.0,
START  =DOMAC/128.0,53.0,0.0,0.050,0.010,20.0
        INDIR,VECTOR/-1.0,1.0,0.0
        GOTO/HULL5
        GORGT/HULL5
LFTCT2 =DOMAC/146.5,73.0,-40.0,12.0,2.5,0.5,HULL5
        FAR,GOLFT,CIRCLE/153.12,81.50,1.5
        GOLFT/HULL5
LFTCT2 =DOMAC/161.42,93.5,-32.1,12.0,2.5,0.5,HULL5
LFTCT2 =DOMAC/175.0,119.0,-24.4,12.0,2.5,0.5,HULL5
        GOLFT,LINE/0.0,150.0,ATANGL,0.0

REMARK  INNERBOTTOM CONTOUR

INBOT  =TABCYL/156.67,162.0,155.46,156.0,153.75,150.0,149.09,138.0
        143.06,126.0,135.82,114.0,127.43,102.0,117.86,90.0,112.59,84.0
        106.96,78.0,100.93,72.0
        GOLFT/INBOT
        FAR,GOLFT,CIRCLE/143.06,126.0,0.0
        GOLFT/INBOT
LFTCT4 =DOMAC/142.5,125.0,-29.4,8.0,2.5,0.5,INBOT
LFTCT4 =DOMAC/134.25,111.62,-33.8,8.0,2.5,0.5,INBOT
        GOLFT,LINE/109.12,80.25,127.88,53.50
        GOPAST/HULL5

REMARK   LIGHTENING HOLES

CTCIR1 =DOMAC/134.0,65.48,0.0,2.0,0.0
LTHOL3 =DOMAC/133.0,92.5,-36.0,7.5,1.5,1.0
LTHOL3 =DOMAC/154.0,111.0,0.0,7.5,1.5,1.0
        FINI
```

Using 6 MACROs and mathematically defined curves, the original program which took 148 instructions can now be programmed with only 25 instructions

STANDARD PROGRAM FOR FLOOR FRAMES 46-52 (Fig. B-10)

```
FLRFR    = MACRO/A
REMARK HULL CONTOUR

HULL     = DOMAC/CUBIC
START    = DOMAC/SETPT
           INDIR VECTOR/-1.0,1.0,0.0
           GOTO/HULL5
           GORGT/HULL5
LFTCT2   = DOMAC/STRG 6
SITEDG   = DOMAC/SITEDG, 3H
LFTCT2   = DOMAC/STRG 7
LFTCT2   = DOMAC/STRG 8
           GOLFT/PLAT 12

REMARK HULL CONTOUR

INBOT    = DOMAC/TABCYL, L10,L9,L8,L7,L6,L5
SITEDG   = DOMAC/SITEDG, 4I
LFTCT4   = DOMAC/L8
LFTCT4   = DOMAC/L7
           GOLFT/LONG55
END      = DOMAC/HULL

REMARK LIGHTENING HOLES
CTCIR1   = DOMAC/C1
LTHOL3   = DOMAC/LH1
LTHOL3   = DOMAC/LH2
TERMAC
```

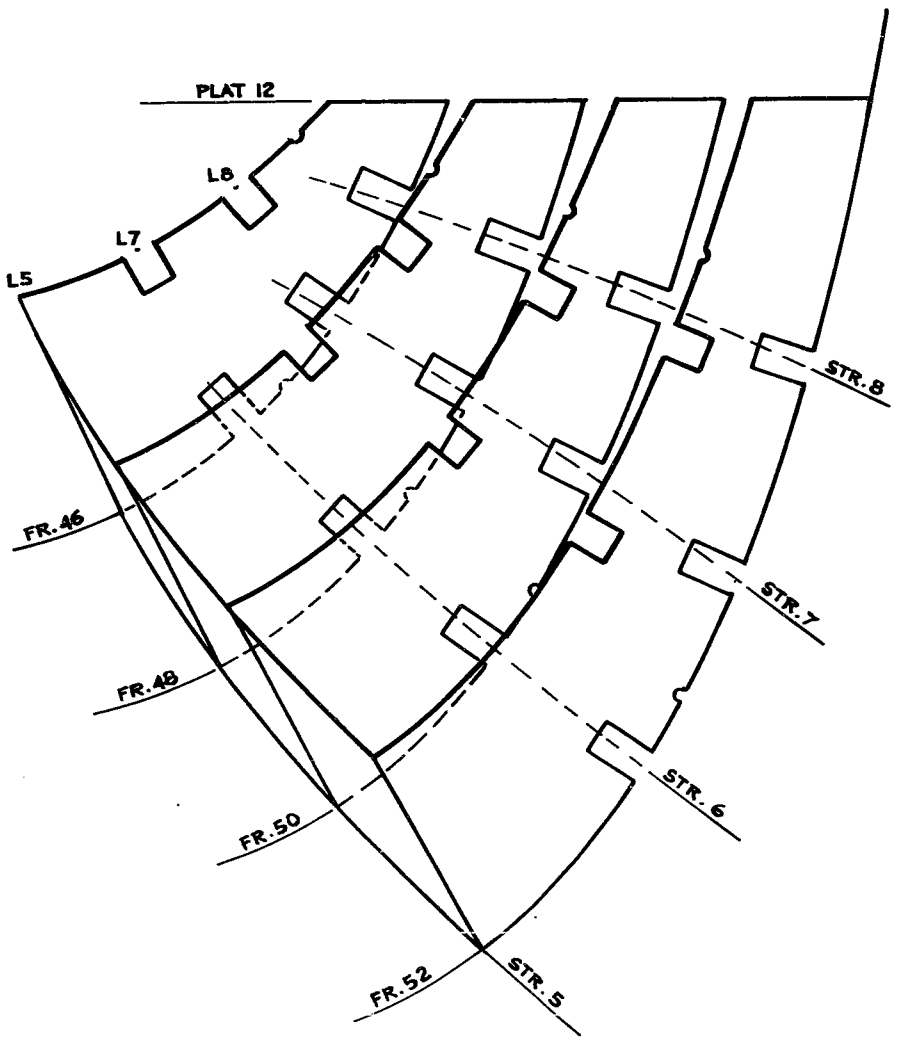


Fig. B-10 Floor Frames 46-52

TYPICAL PARTS PROGRAM FOR FLOOR FRAMES 46-52 USING FULL FRAME MACROS

FLOOR FRAME 46

The complete parts program would consist of only one instruction:

FLFR = DOMAC/46

This would require that a lead deck of cards locating the structural points and defining the contours which describe Frame 46 be inserted into the computer just preceeding the part program card.

The following information would be required:

1. Cubic equations, hull
2. Location Str 6
3. Location Sight Edge #3 Hull Plate
4. Location Strg. 7
5. Location Strg. 8
6. Description of Plate 12
7. Location Loditudinals 10,9,8,7,6,5
8. Location Sight Edge #4, inner-bottom plate
9. Description of Longitudinal 55
10. Locations of lightening hole cutouts.

The above should be readily available on pre-punched cards as output data from the mathematical loft.

FLOOR FRAMES 47-52

The above process would be repeated with the corresponding data to produce tapes for floor frames 47 through 52.

Appendix C

METHOD FOR CORRECTING ERRORS IN PROGRAMMING

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2. Correcting Phase II Output	C-3
POST PROCESSOR OUTPUT.	C-4

Appendix C

METHOD FOR CORRECTING ERRORS IN PROGRAMMING

PHASE I INPUT

When operating Phase I of AUTOMAP with Program Switch 2 on, some errors made in programming will cause the computer to type an error message symbol, the erroneous instruction statement, and then stop. This procedure is given in detail in the AUTOMAP Manual (Ref. 3). These errors are either from imposing an impossible requirement on the program or are from instances where insufficient or inaccurate data have been given the program, or a card has been key-punched improperly.

Most of these errors can be corrected by simply typing the correct instruction and entering it into the computer. The compiling can then be continued. However, the errors in some of these instructions are not readily discernable or cannot easily be changed by typewritten correction. In such cases, it will be necessary to revise the input cards in order to correct the error.

PHASE II OUTPUT

On occasion, an erroneous instruction will be accepted by Phase I. In such instances, the program logic was acceptable to the computer program, but the part was not properly defined. An example would be where a corner snipe instruction had been omitted so that the computer produced a 90^{o} corner. Another example would be where the machine was instructed to turn in the wrong direction, but in so doing, was still able to find a logical path.

Phase II, if operated with Switch 1 in the ON position, will type out

coordinates which define the cutting path. This is a time-consuming process, but an experienced programmer can visually inspect this data and spot such errors.

A faster and more foolproof method of locating such errors is to plot the data produced by Phase II on an automatic X-Y plotter. (Appendix D).

The selection of the method for correcting such errors will be dependent upon the type and complexity of the error. In the extreme, it may be necessary to go back to the original program, correct the data, and re-run both Phase I and II. However, the errors are not usually of this magnitude, and therefore some shortcut procedures can save computer time.

It is possible to make corrections in either the output card deck of Phase I, which requires re-running at least a portion of Phase II, or to correct the cards in the output of Phase II. Again, the selection will depend upon the type and complexity of the error.

1. Correcting Phase I Output

   If the error is fairly complex but generally confined to only one section of the part, it is possible to correct only that part of the original program and re-run it through Phase I. The resulting new cards can be substituted in the original Phase I output and the entire program re-run through Phase II.

   If the error is relatively simple, requiring merely the insertion of an omitted instruction or the correction of an erroneous instruction, a new card may be keypunched in the format of the Phase I output and and substituted in the Phase I output deck. This deck can then be re-run through Phase II.

   If the correction made in this manner is merely a replacement of a

bad card a simple substitution is all that is required. However, if the correction is made by the addition of a new card, the sequence numbers in Columns 77 through 80 must be omitted to permit the card to bypass the Phase II sequence check.

A whole series of instructions can be inserted in this manner, but the relative complexity of these instructions will determine whether it is more efficient to do so or to go back and change the original program card.

2. Correcting Phase II Output

A considerable savings can be made if the programmer can correct the Phase II output cards, rather than correct Phase I and re-run it again. Here again, the complexity of the correction will determine the method to be used.

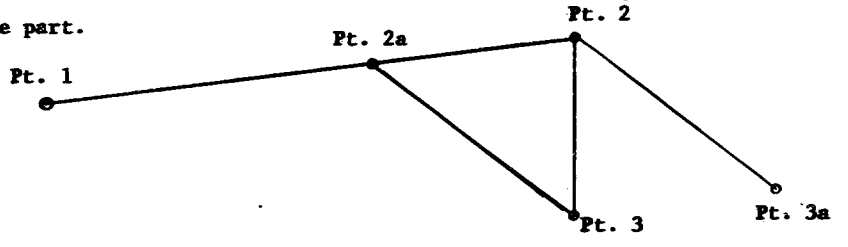
If simple changes are desired which do not require mathematical calculations, such as changes of feedrate, auxiliary instruction, or simple point relocations, generally involving only one card, a new card can be keypunched in the format of Phase II output and substituted directly. The deck is thereby made ready for the post processing operation with a minimum of effort.

It is possible to change a complete series of motions in this manner and it might prove economical if the new coordinate data is readily available. It must be kept in mind, however, that in Phase II output the coordinates designate the path taken by the center of the torch, not the edge of the part.

POST PROCESSOR OUTPUT (Punched Tape)

The punched tape used to operate the flame cutting machine* contains information for the motions required which is punched in incremental dimensional form. This means that the extent of motion in both the X axis and Y axis is given in individual dimensions on a motion block in the tape. This does not in any way give information as to the location of the torch, either before or after the motion, but tells how far and in which direction the machine is to move.**

If an error does occur in the data given on the tape (visible or lot of full plate) or if changes are desired, it is nearly always necessary to change two blocks of information to avoid unwanted motions in the rest of the part.



For example, assuming the path desired in the above sketch is through Points 1, 2, 3, but through error the path obtained was Point 1, 2a, 3. The data blocks as they appear and as they should be, are:

Line	Incorrect	Correct
1 - 2	X 19000 Y 0	X 30000 Y 0
2 - 3	X 11000 Y-08000	X 0 Y-08000

One can see that if only the first information block is corrected, the result would be to have the torch end up at Point 3a, which only changes the location of the error and introduces this error to all subsequent motions.

---

*The Air Reduction Co., Tape-O-Graph, with GE Mark Century Director

**Not true for all makes of directors.

There are two basic ways to correct or change a tape, the use of which depends on the extent of the change desired.

For major changes involving many blocks of data, or requiring substantial calculation work, the best answer would be to modify the parts program and run the whole job through the computer system again.

If the change desired affects only a few blocks of data and/or requires little calculation work, it would be cheaper to use a tape-punching typewriter for the repair. By inserting the original tape into the card reader, both a duplicate tape and a typeout of the statements can be obtained simultaneously. When the reader reaches that part of the tape where the correction is required, it can be shut off and the correct data punched into the tape. After the new data is punched, the original tape can be threaded through the reader to a point agreeing with the corrected tape. The reader and punch may then be turned on and the remainder of the new tape can be duplicated from the old.

As this latter operation can be easily handled by typist operating a flexo-writer, it can be readily seen that many changes could be most economically handled in this manner with a minimum of instruction from the parts programmer.

In effect, this procedure uses manual programming to produce the new section of the tape.

If, during the course of cutting an actual part, an error causes an incorrect machine function, an experienced operator can read the tape itself and locate the error. This is one of the advantages that punched paper tape has over magnetic tape. If the operator locates such an error, the tape can usually be repaired in the above manner.

Appendix D

AUTOMAP PHASE II PLOTTING PROGRAM

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Appendix D

AUTOMAP PHASE II PLOTTING PROGRAM

INTRODUCTION

This program plots the output of AUTOMAP II, Phase II, using an IBM-1620 computer equipped with a Cal-Comp plotter. It is used primarily for confirming the accuracy of the data prior to making the control tape. Plotting speed is approximately one inch per second. This Appendix includes operating instructions, a short discussion of the theory involved, a program flow chart, and a program listing.

OPERATING INSTRUCTIONS

1. Place Phase II Plotting Program in Read Hopper
2. Clear memory
   Reset
   Insert 26 00008 00009 R-S
   After memory clear, push instant stop.
3. Set Program Switches
   Sw 1 - On to scale, off to plot full-scale
   Sw 2, 3, 4 - not used
4. Push load button on 1622
   Push reader start to read last two cards
5. Push computer start. If Sw 1. was on, computer will type "enter scale." The scaling factor is entered on the typewriter in the format XX00 and is a multiplier. For example, to plot 1/10 scale, 0010 would be typed followed by R-S key. For 2 X scale, 0200 would be typed.

6. Place output of Phase II into read hopper
   Ready the plotter
   Push reader start on 1622

7. To plot another part, repeat Step 5.

Error messages:

Pi = Given a coordinate larger than 999.999.

Other messages are self-explanatory

METHOD

The plotter traces straight line increments along one of the eight directions (four axes) shown in Fig. D-1. The increments are .01" in the X and Y directions, and .01414" for the inclined directions.

A punch tape instruction, 1, 2, 3, ..., 8, will move the plotter in one of eight specific directions. Instruction 0 will raise the pen, and 9 will lower the pen.

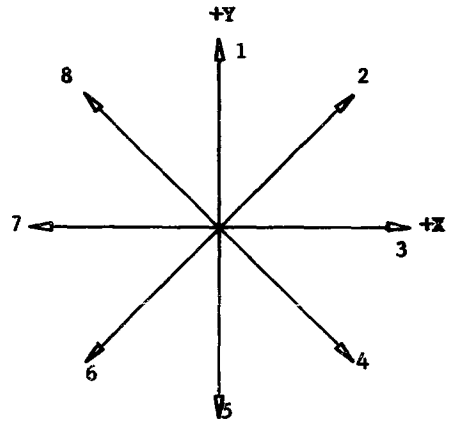


Fig. D-1 Direction of Movement of Plotter

Given a particular quadrant (Fig. D-2), and a specific point, the line connecting this point to the origin must fall in one of the five cases listed below:

Case 1	Point P :	$\Delta Y = 0$
Case 2	Point Q :	$\Delta X > \Delta Y$
Case 3	Point R :	$\Delta X = \Delta Y$
Case 4	Point S :	$\Delta Y > \Delta X$
Case 5	Point T :	$\Delta X = 0$

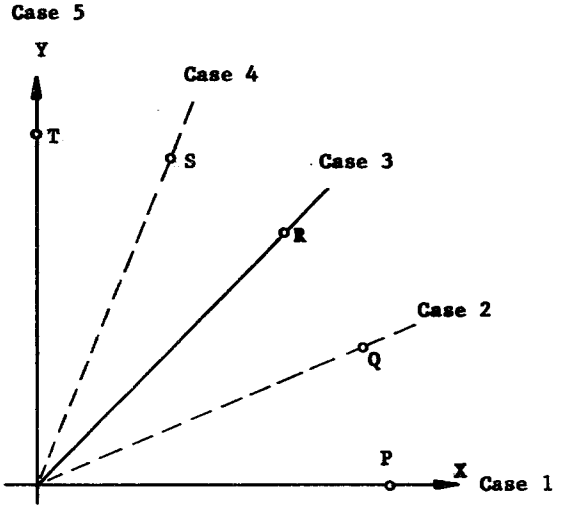


Fig. D-2

After determining the case, the problem is reduced to positioning the point to one side of the bisector of the quadrant.

For Point P having a null or less than .005 increment in the Y direction, the procedure is as follows:

1. Round off the increment at the 1/100 position by adding or subtracting .005 to its value if positive or negative respectively.

2. Add this rounded value to the corresponding coordinate of Point 0 and store it as the origin to determine the increment for the next point to be joined.
3. Check for digit in the units position of the absolute value of the increment for fast one-inch moves.
4. Check for digit in the 1/10 position for fast 1/10th-inch moves.
5. Test for digit in the 1/100 position for single moves.

By subtracting one from the corresponding position after each move, the increment will be zero at the completion of the total move.

For Point R the procedure is the same as mentioned above for Point P, with the difference that both increments X and Y ... , (Fig. D-2) will be rounded off and added to the coordinates of Point 0 .

The method for plotting those Points Z having unequal increments in X and Y is as follows:

1. Get the ratio of the smaller to the larger increment in absolute value.
2. Round off the increments X and Y and add them to the coordinates of the Point 0 to use these new values as the origin to calculate the increments for the next point to be joined.
3. Approximate the line $\overline{OQ}$ (Fig. D-3) with segments $\overline{OA}$, $\overline{AB}$, etc., in the following manner:
4. Set an XY counter equal to .005
5. Add $\overline{NM}$ (Ratio x .01") to the counter
6. Compare the counter with $\overline{AM}$ (= .01) (check for digit in the 1/100 position)
    a. If the counter is greater, it means that we are closer to the actual line going through the diagonal rather than the horizontal line

$$\overline{NM} + .005 > \overline{AM}$$

$$\therefore \overline{AM} - \overline{NM} < .005$$

(Note: The XY counter has to be reduced by $\overline{MA}$ after the diagonal move and the cycle goes back to Step 5.)

b. If the counter is less than $\overline{MA}$ the closest path is the horizontal line

$$\overline{MH} + .005 < \overline{AM}$$
$$\therefore \overline{AM} - \overline{MH} > .005$$

(Note: The cycle goes back directly to Step 5 after the horizontal move.)

An analysis of the moves from 0 to B of Fig. D-3 will help to clarify the method.

1. XY counter = $\overline{MH} + .005 > \overline{AM}$
2. Move $\overline{OA}$
3. XY counter = $\overline{MH} + .005 - \overline{AM}$
4. XY counter = $\overline{MH} + .005 - \overline{AM} + \overline{MH}$
   $= 2\overline{MH} + .005 - \overline{AM}$
5. XY counter = $\overline{LK} + .005 - \overline{AM} < \overline{AM}$
   $\therefore \overline{LK} + .005 < 2\overline{AM}$
   $.005 < \overline{HK} - \overline{LK}$
6. Move $\overline{AB}$

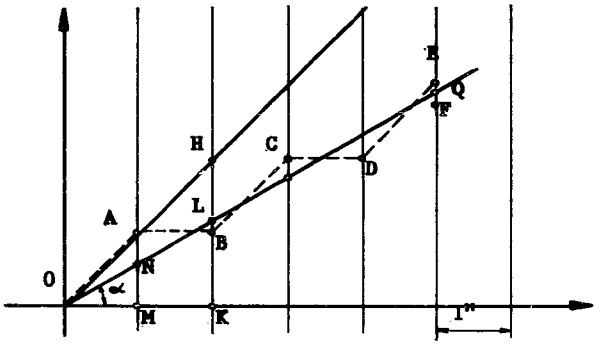
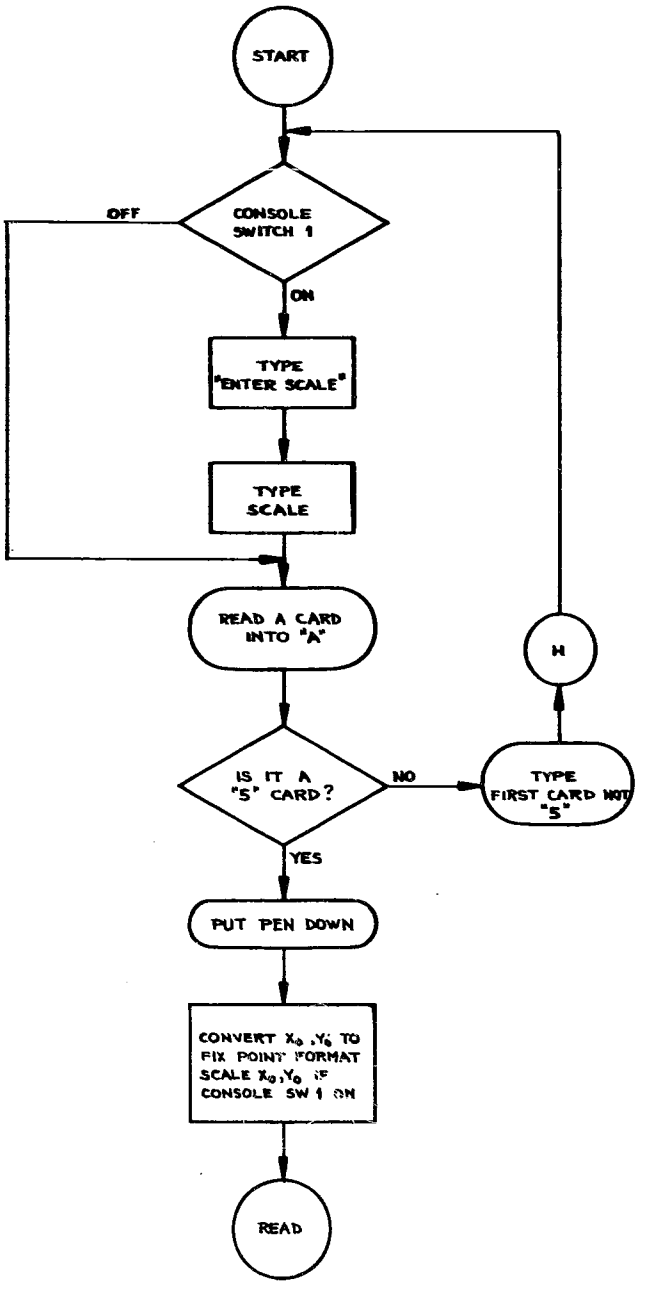
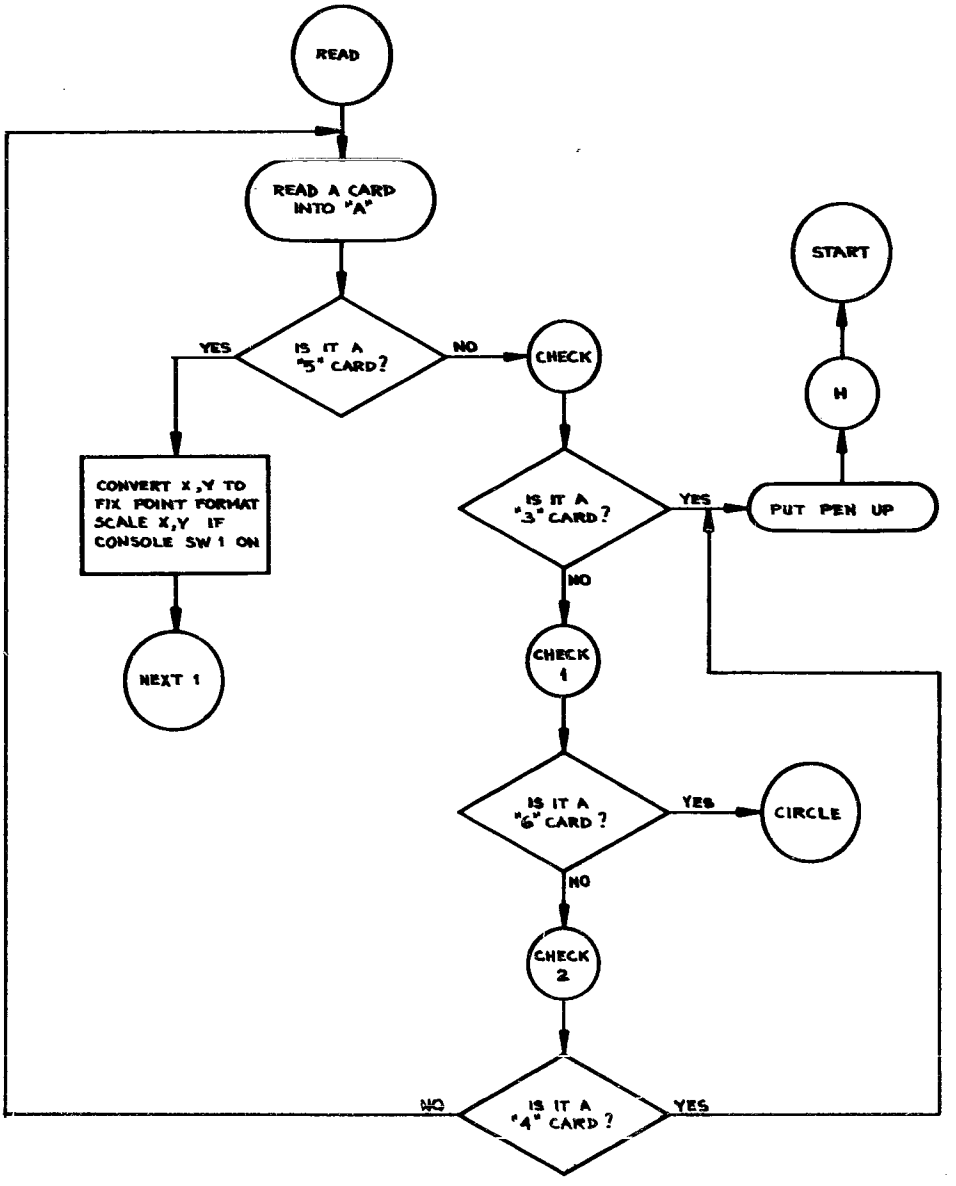


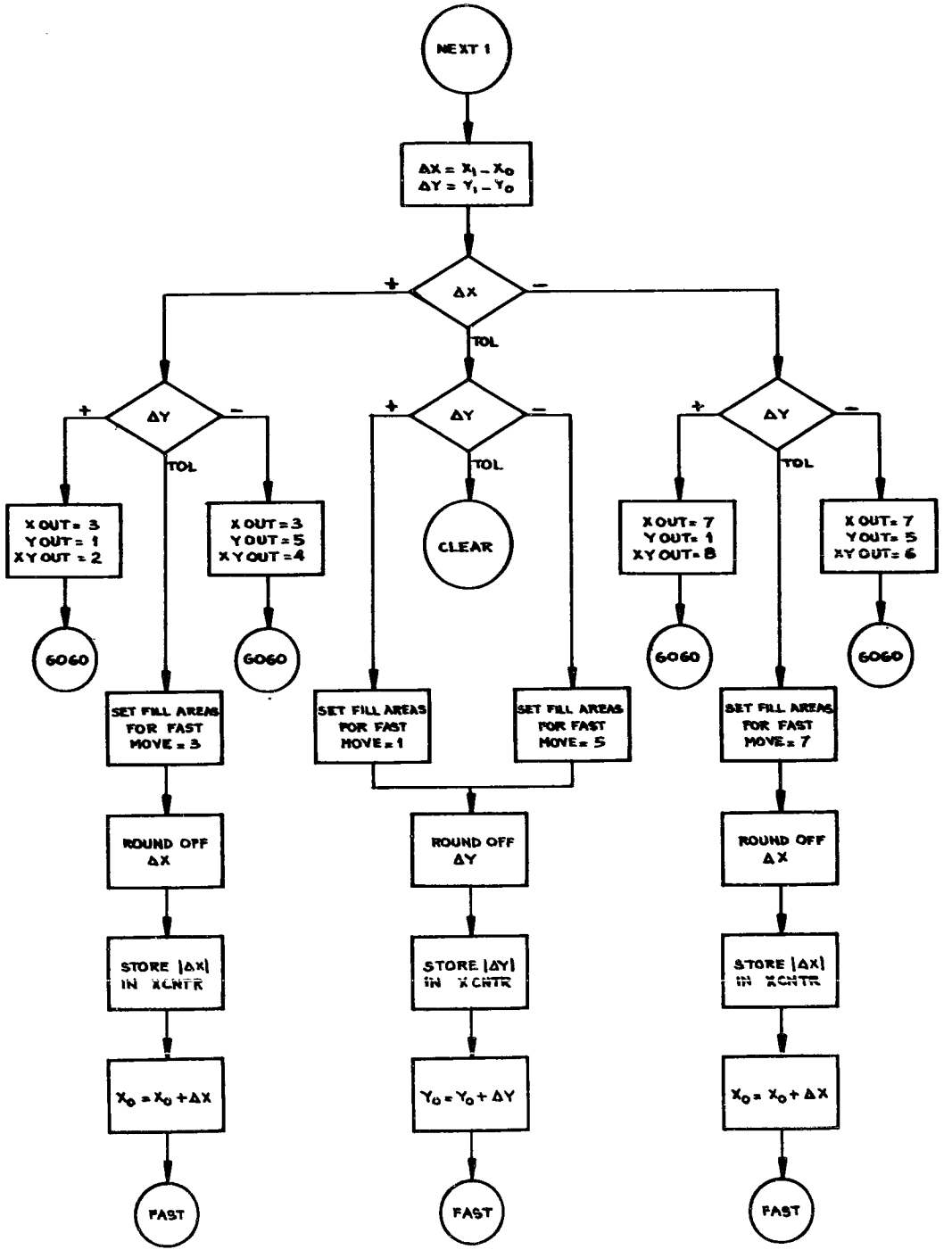
Fig. D-3

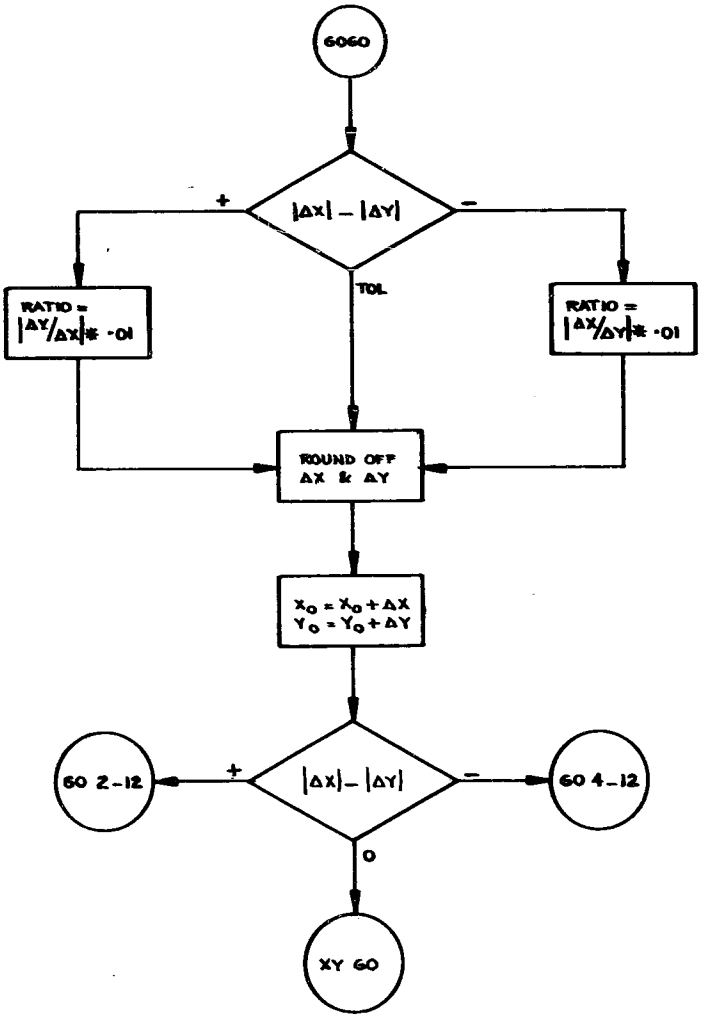
In the case of a movement along a circular arc, the procedure is to segment the arc into 10^{o} segments and treat these segments as straight lines.

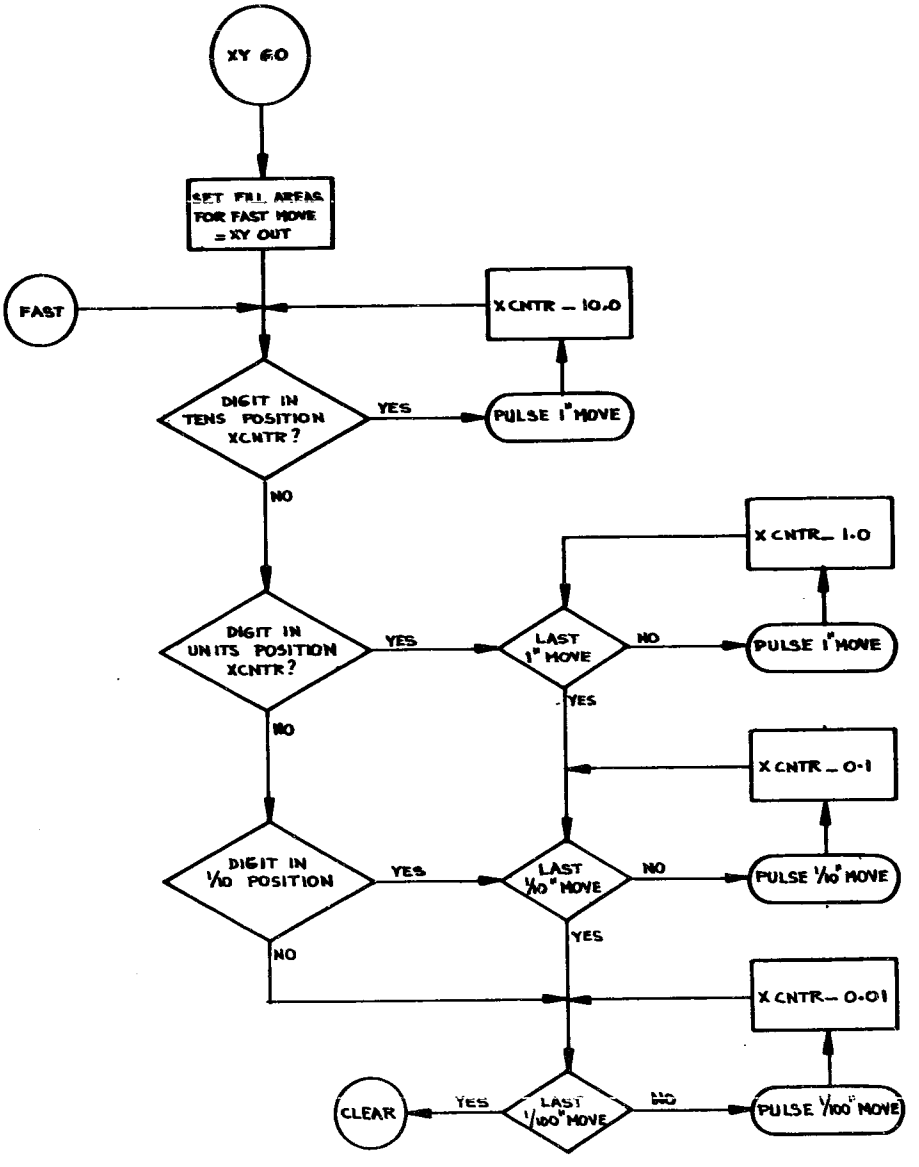
PROGRAM FLOW CHART - PHASE II AUTOMAP

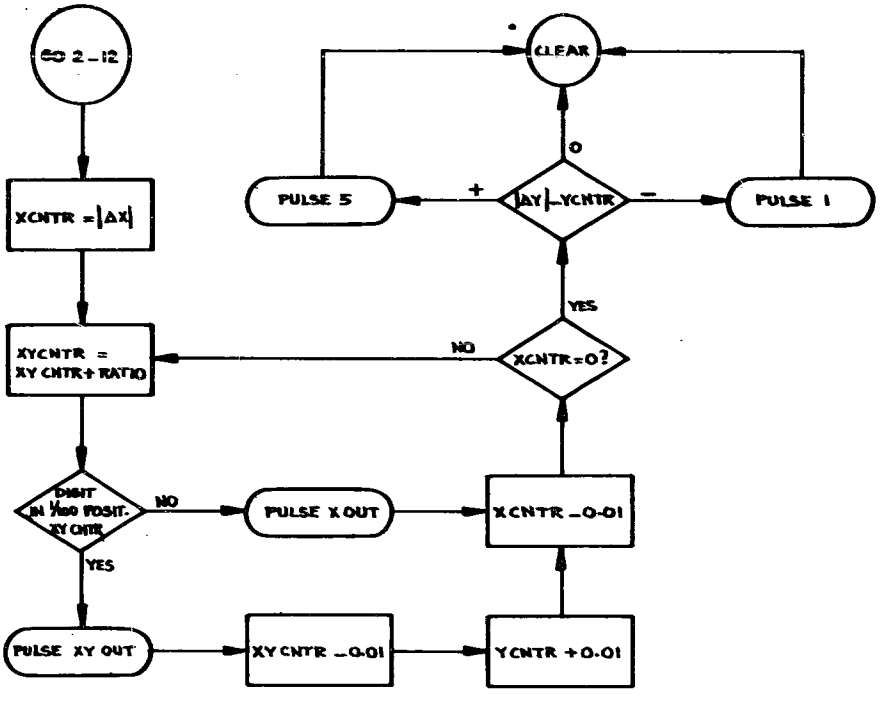


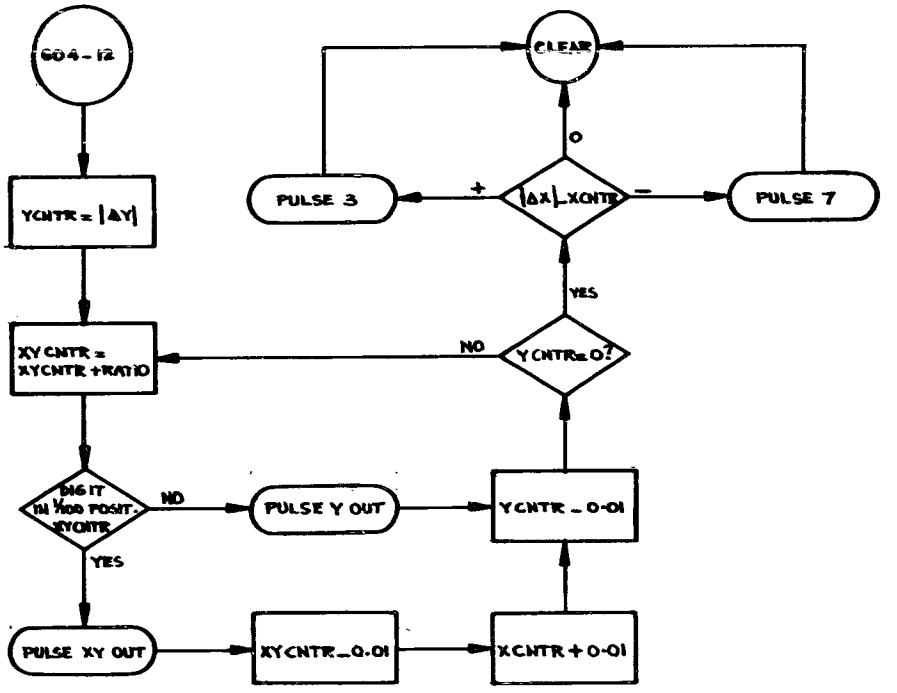

READ
READ A CARD INTO "A"
IS IT A "5" CARD?
YES
NO
CONVERT X,Y TO FIX POINT FORMAT SCALE X,Y IF CONSOLE SW 1 ON
NEXT 1
CHECK
IS IT A "3" CARD?
YES
PUT PEN UP
H
START
NO
CHECK 1
IS IT A "6" CARD?
YES
CIRCLE
NO
CHECK 2
IS IT A "4" CARD?
NO
YES

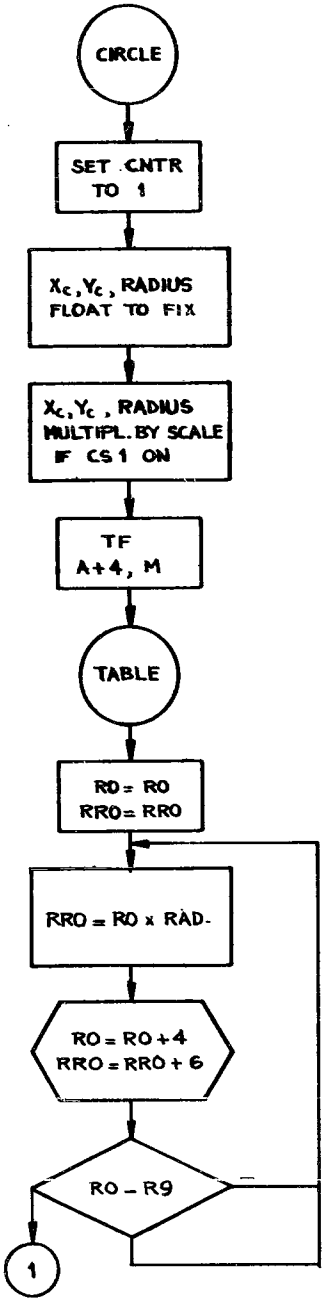

NEXT 1
ΔX = X1 − X0
ΔY = Y1 − Y0
ΔX
+
−
TOL
ΔY
+
−
TOL
X OUT = 3
Y OUT = 1
XY OUT = 2
X OUT = 3
Y OUT = 5
XY OUT = 4
CLEAR
X OUT = 7
Y OUT = 1
XY OUT = 8
X OUT = 7
Y OUT = 5
XY OUT = 6
6060
SET FILL AREAS FOR FAST MOVE = 3
SET FILL AREAS FOR FAST MOVE = 1
SET FILL AREAS FOR FAST MOVE = 5
SET FILL AREAS FOR FAST MOVE = 7
ROUND OFF ΔX
ROUND OFF ΔY
STORE |ΔX| IN XCNTR
STORE |ΔY| IN XCNTR
X0 = X0 + ΔX
Y0 = Y0 + ΔY
FAST

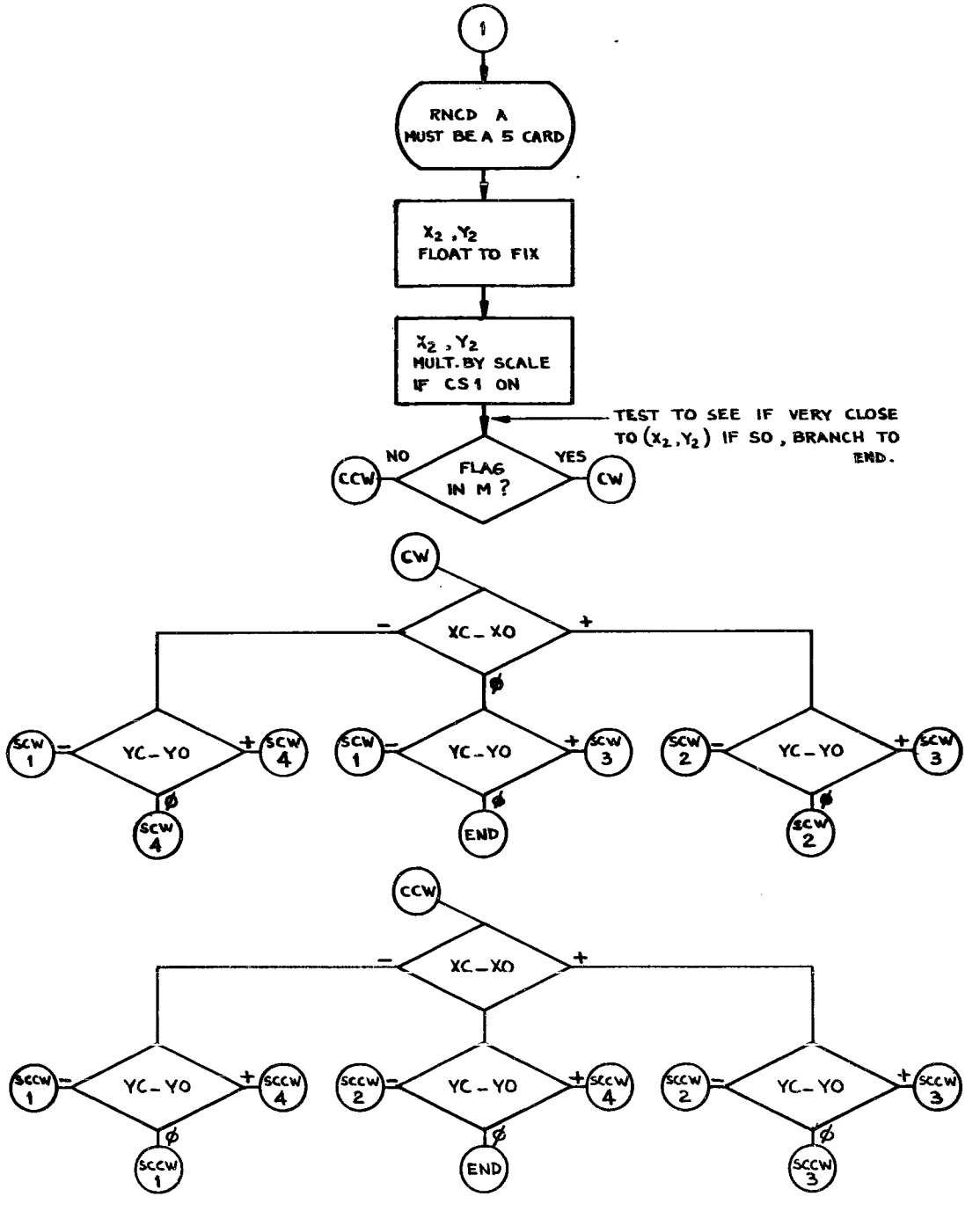

6060
|ΔX| – |ΔY|
+
–
TOL
RATIO = |ΔY/ΔX| * .01
RATIO = |ΔX/ΔY| * .01
ROUND OFF ΔX & ΔY
X0 = X0 + ΔX
Y0 = Y0 + ΔY
|ΔX| – |ΔY|
+
–
0
60 2-12
60 4-12
XY 60

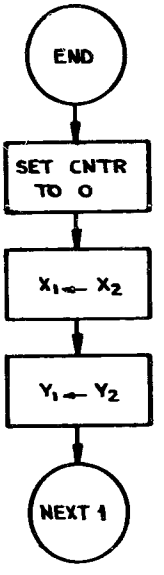

XY GO
SET FILL AREAS FOR FAST MOVE = XY OUT
FAST
X CNTR — 10.0
DIGIT IN TENS POSITION XCNTR?
YES
PULSE 1" MOVE
NO
X CNTR — 1.0
DIGIT IN UNITS POSITION XCNTR?
YES
LAST 1" MOVE
NO
PULSE 1" MOVE
YES
NO
X CNTR — 0.1
DIGIT IN 1/10 POSITION
YES
LAST 1/10" MOVE
NO
PULSE 1/10" MOVE
YES
NO
X CNTR — 0.01
CLEAR
YES
LAST 1/100" MOVE
NO
PULSE 1/100" MOVE

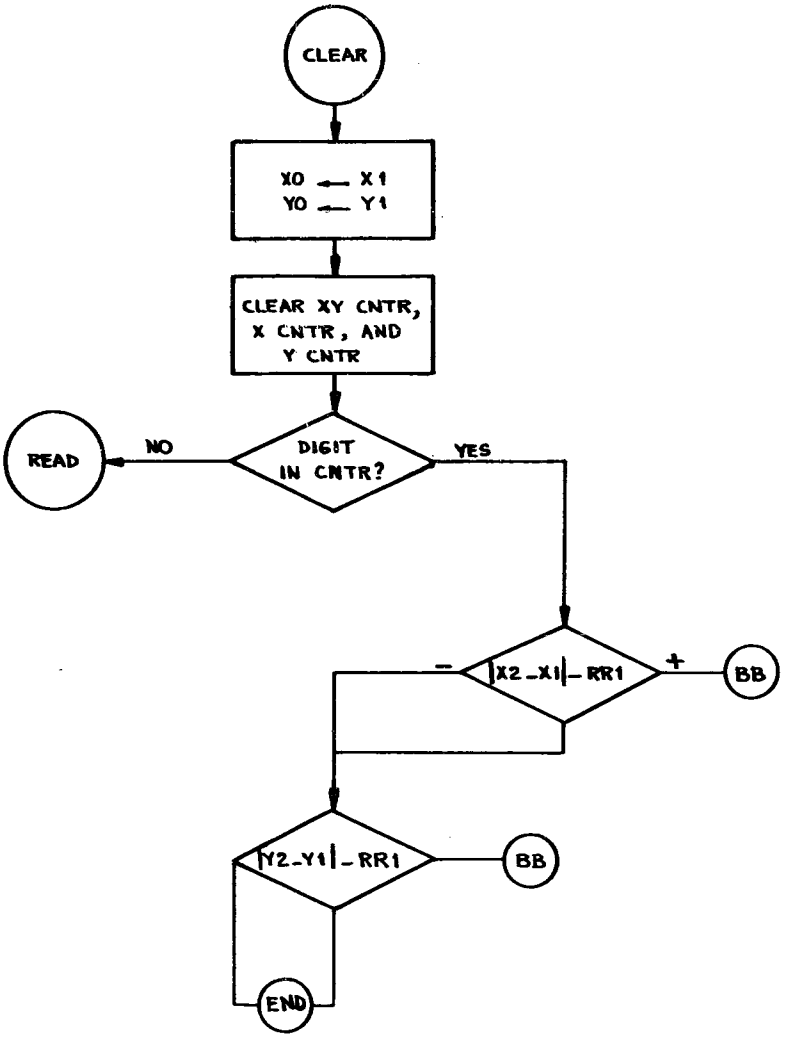

GO 2-12
XCNTR = |ΔX|
XYCNTR = XY CNTR + RATIO
DIGIT IN X AND POSIT. XY CNTR
NO
YES
PULSE XY OUT
XY CNTR -0.01
PULSE X OUT
XCNTR -0.01
YCNTR +0.01
XCNTR=0?
NO
YES
|ΔY| - YCNTR
+
-
0
PULSE 5
PULSE 1
CLEAR


604 - 12
YCNTR = |ΔY|
XY CNTR = XYCNTR + RATIO
DIG IT IN MOD POSIT. XYCNTR
NO
YES
PULSE XY OUT
PULSE Y OUT
XYCNTR - 0.01
YCNTR - 0.01
XCNTR + 0.01
YCNTR = 0?
NO
YES
|ΔX| - XCNTR
+
0
-
PULSE 3
PULSE 7
CLEAR


CIRCLE
SET CNTR TO 1
X_c, Y_c, RADIUS FLOAT TO FIX
X_c, Y_c, RADIUS MULTIPL. BY SCALE IF CS 1 ON
TF A+4, M
TABLE
R0 = R0 RR0 = RR0
RR0 = R0 x RAD-
R0 = R0 + 4 RR0 = RR0 + 6
R0 - R9
1


1
RNCD A
MUST BE A 5 CARD
X2 , Y2
FLOAT TO FIX
X2 , Y2
MULT. BY SCALE
IF CS 1 ON
TEST TO SEE IF VERY CLOSE TO (X2 , Y2) IF SO , BRANCH TO END.
NO
FLAG
IN M ?
YES
CCW
CW
CW
XC - XO
YC - YO
SCW 1
SCW 4
SCW 3
SCW 2
END
CCW
XC - XO
YC - YO
SCCW 1
SCCW 4
SCCW 2
SCCW 3
END


END
SET CNTR TO 0
X1 ← X2
Y1 ← Y2
NEXT 1


CLEAR
X0 ← X1
Y0 ← Y1
CLEAR XY CNTR, X CNTR, AND Y CNTR
DIGIT IN CNTR?
NO
READ
YES
|X2-X1| - RR1
-
+
BB
|Y2-Y1| - RR1
BB
END

PROGRAM LISTING - AUTOMAP PHASE II PLOTTING PROGRAM

```
 I-ADD OP              P/L LABEL   OP       OPERANDS

3600072005003600201005004400012002752600059002742500011000002600090002 69  -
2600095002643100000002002600114002742500000000114900012000 00             -
02000                             DORG   2000*
02000 47 02084 00100        START BNC1   GO*
02012 34 00000 00102              RCTY    *
02024 39 10883 00100              WATY   MES2*
02036 34 00000 00102              RCTY    *
02048 36 09621 00100              RNTY   A*
02060 32 09621 00000              SF     A*
02072 26 09710 09624              TF     SCALE,A&3*
02084 26 10911 09706        GO    TF     XCNTR,ZERO1*
02096 26 10838 09706              TF     DELTAX,ZERO1*
02108 26 10844 09706              TF     DELTAY,ZERO1*
02120 26 10917 09706              TF     YCNTR,ZERO1*
02132 26 10923 09706              TF     XYCNTR,ZERO1*
02144 16 09748 000-0              TFM    CNTR,0,10*
02156 36 09621 00500        FIRST RNCD   A*
02168 14 09622 000-5              CM     A&1,5,10*
02180 46 02240 01200              BE     *&60*
02192 34 00000 00102              RCTY    *
02204 39 10847 00100              WATY   MES1*
02216 48 00000 00000              H       *
02228 49 02000 00000              B      START*
02240 38 10762 00200              WNPT   PENDWN - 1*
02252 26 09499 09640              TF     FLTING,A&19*
02264 17 09272 000-0              BTM    FLTOFX,0,10*
02276 32 09500 00000              SF     FIXED-14*
02288 26 09716 09505              TF     X0,FIXED-9*
02300 71 09716 09506              MF     X0,FIXED-8*
02312 26 09499 09650              TF     FLTING,A&29*
02324 17 09272 000-0              BTM    FLTOFX,0,10*
02336 32 09500 00000              SF     FIXED-14*
02348 26 09722 09505              TF     Y0,FIXED-9*
02360 71 09722 09506              MF     Y0,FIXED-8*
02372 47 02480 00100              BNC1   READ*
02384 23 09716 09710              M      X0,SCALE*
02396 32 00092 00000              SF     92*
02408 26 09716 00097              TF     X0,97*
```

```
I-ADD OP                P/L LABEL   OP      OPERANDS

02420 71 09716 00099            MF      X0,99*
02432 23 09722 09710            M       Y0,SCALE*
02444 32 00092 00000            SF      92*
02456 26 09722 00097            TF      Y0,97*
02468 71 09722 00099            MF      Y0,99*
02480 36 09621 00500        READ    RNCD    A*
02492 14 09622 000-5            CM      A&1,5,10*
02504 47 09140 01200            BNE     CHECK*
02516 26 09499 09640            TF      FLTING,A&19*
02528 17 09272 000-0            BTM     FLTOFX,0,10*
02540 32 09500 00000            SF      FIXED-14*
02552 26 09728 09505            TF      X1,FIXED-9*
02564 71 09728 09506            MF      X1,FIXED-8*
02576 26 09499 09650            TF      FLTING,A&29*
02588 17 09272 000-0            BTM     FLTOFX,0,10*
02600 32 09500 00000            SF      FIXED-14*
02612 26 09734 09505            TF      Y1,FIXED-9*
02624 71 09734 09506            MF      Y1,FIXED-8*
02636 47 02756 00100            BNC1    NEXT1*
02648 23 09728 09710            M       X1,SCALE*
02660 32 00092 00000            SF      92*
02672 26 09728 00097            TF      X1,97*
02684 71 09728 00099            MF      X1,99*
02696 23 09734 09710            M       Y1,SCALE*
02708 32 00092 00000            SF      92*
02720 26 09734 00097            TF      Y1,97*
02732 71 09734 00099            MF      Y1,99*
02744 41 00000 00000            NOP      *
02756 KO 10838 09728 1660   NEXT1   TF      DELTAX,X1,01*
02768 KK 10838 09716 1670           S       DELTAX,X0,01,       TOTAL INCREMENT IN THE X DIRECTION*
02780 KO 10929 10838 1680           TF      ABSDX,DELTAX,01*
02792 L3 10929 00000 1690           CF      ABSDX,,0*
02804 KO 10844 09734 1700           TF      DELTAY,Y1,01*
02816 KK 10844 09722 1710           S       DELTAY,Y0,01,       TOTAL INCREMENT IN THE Y DIRECTION*
02828 KO 10772 10844 1720           TF      ABSDY,DELTAY,01*
02840 L3 10772 00000 1730           CF      ABSDY,,0*
02852 KM 10929 10827 1740           C       ABSDX,TOLER,01,     TEST FOR ABSDX LESS THAN .005*
02864 M6 02888 01100 1750           BP      *&24,,0*
```

```
I-ADD OP              P/L LABEL   OP      OPERANDS

02876 M9 04544 00000 1760         B       NEXT5,,0*
02888 KM 10838 09706 1770         C       DELTAX,ZERO1,01,    TEST FOR DELTAX # 0*
02900 M6 03092 01100 1780         BP      NEXT2,,0*
02912 KM 10772 10827 1790         C       ABSDY,TOLER,01,     TEST FOR ABSDY LESS THAN .005*
02924 M6 02948 01100 1800         BP      *&24,,0*
02936 M9 04796 00000 1810         B       NEXT6,,0*
02948 KM 10844 09706 1820         C       DELTAY,ZERO1,01,    TEST FOR DELTAY # 0*
02960 M6 03032 01100 1830         BP      NEXT3,,0*
                     1840 * -NEG  ATIV    E DELTAX AND DELTAY-*
02972 JO 03398 J0645 1850         TFM     XOUT,SEVSO-1,017*
02984 JO 03770 J0417 1860         TFM     YOUT,FIVEO-1,017*
02996 JO 03626 J0531 1870         TFM     XYOUT,SIXSO-1,017*
03008 JO 03998 J0531 1880         TFM     GOXY2&6,SIXSO-1,017*
03020 M9 03260 00000 1890         B       GOGO,,0*
                     1900 * -NEG  ATIV    E DELTAX AND POSITIVE DELTA Y-*
03032 JO 03398 J0645 1910 NEXT3   TFM     XOUT,SEVSO-1,017*
03044 JO 03770 -9961 1920         TFM     YOUT,ONESO-1,017*
03056 JO 03626 J0759 1930         TFM     XYOUT,EIGHO-1,017*
03068 JO 03998 J0759 1940         TFM     GOXY2&6,EIGHO-1,017*
03080 M9 03260 00000 1950         B       GOGO,,0*
                     1960 * -POS  ITIV    E DELTAX-*
03092 KM 10772 10827 1970 NEXT2   C       ABSDY,TOLER,01,     TEST FOR ABSDY LESS THAN .005*
03104 M6 03128 01100 1980         BP      *&24,,0*
03116 M9 04796 00000 1990         B       NEXT6,,0*
03128 KM 10844 09706 2000         C       DELTAY,ZERO1,01,    TEST FOR DELTAY # 0*
03140 M6 03212 01100 2010         BP      NEXT4,,0*
                     2020 * -POS  ITIV    E DELTAX AND NEGATIVE DELTAY-*
03152 JO 03398 J0189 2030         TFM     XOUT,THREO-1,017*
03164 JO 03770 J0417 2040         TFM     YOUT,FIVEO-1,017*
03176 JO 03626 J0303 2050         TFM     XYOUT,FOURO-1,017*
03188 JO 03998 J0303 2060         TFM     GOXY2&6,FOURO-1,017*
03200 M9 03260 00000 2070         B       GOGO,,0*
                     2080 * -POS  ITIV    E DELTAX AND DELTAY-*
03212 JO 03398 J0189 2090 NEXT4   TFM     XOUT,THREO-1,017*
03224 JO 03770 -9961 2100         TFM     YOUT,ONESO-1,017*
03236 JO 03626 J0075 2110         TFM     XYOUT,TWOSO-1,017*
03248 JO 03998 J0075 2120         TFM     GOXY2&6,TWOSO-1,017*
03260 KM 10929 10772 2180 GOGO    C       ABSDX,ABSDY,01,     TEST FOR BIGGER INCREMENT*
```

```
 I-ADD OP              P/L LABEL   OP      OPERANDS

03272 M6 04040 01200 2190         BE    OK,,0*
03284 M7 03668 01300 2200         BN    YBIGER,,0*
                     2210  * -DEL TAX   GREATER THAN DELTAY-*
03296 2Q 00096 10772 2220         LD    96,ABSDY,1*
03308 2R 00097 10929 2230         D     97,ABSDX,1*
03320 32 00091 00000 2240         SF    91*
03332 K6 09587 00093 2250         TF    RATIO,93,0,        RATIO DELTAY/DELTAX*
03344 M9 04040 00000 2260         B     OK,,0*
                     2270  * -DEL TAX   GREATER THAN DELTAY-*
03356 KO 10911 10837 2280         TF    XCNTR,DELTAX-1,01, SET XCOUNTER EQUAL TO DELTAX*
03368 KJ 10923 09587 2290  GO2    A     XYCNTR,RATIO,01,   MODIFY XYCOUNTER ADDING RATIO*
03380 ML 03620 10920 2300         BD    GOXY1,XYCNTR-3,01, TEST FOR DIGIT IN XYCOUNTER*
03392 38 00000 00200 2310         WNPT   *
03398    00005       2320  XOUT   DS    5,*-5*
03404 J2 10911 000-1 2330  GO3    SM    XCNTR,1,010*
03416 J4 10911 -0000 2340         CM    XCNTR,0,07,        TEST FOR LAST MOVE*
03428 M6 03368 01100 2350         BP    GO2,,0*
                     2360  * -FIN AL A DJUSTMENT IN THE Y DIRECTION-*
03440 MM 03536 10844 2370         BNF   *&96,DELTAY,01,    TEST FOR NEGATIVE DELTAY*
                     2380  * -NEG ATIV  E DELTAY-*
03452 KM 10843 10916 2390         C     DELTAY-1,YCNTR-1,01,TEST FOR FINAL ADJUSTMENT*
03464 M6 05024 01200 2400         BE    CLEAR,,0*
03476 M7 03512 01300 2410         BN    *&36,,0*
03488 L8 10417 00200 2420         WNPT  FIVEO-1,,0*
03500 M9 05024 00000 2430         B     CLEAR,,0*
03512 L8 09961 00200 2440         WNPT  ONESO-1,,0*
03524 M9 05024 00000 2450         B     CLEAR,,0*
                     2460  * -POS ITIV  E DELTAY-*
03536 KM 10843 10916 2470         C     DELTAY-1,YCNTR-1,01,TEST FOR FINAL ADJUSTMENT*
03548 M6 05024 01200 2480         BE    CLEAR,,0*
03560 M7 03596 01300 2490         BN    *&36,,0*
03572 L8 09961 00200 2500         WNPT  ONESO-1,,0*
03584 M9 05024 00000 2510         B     CLEAR,,0*
03596 L8 10417 00200 2520         WNPT  FIVEO-1,,0*
03608 M6 05024 01200 2530         BE    CLEAR,,0*
                     2540  * -DIG IT I  N XYCOUNTER %DELTAX GRATER THAN DELTAY¤-*
03620 38 00000 00200 2550  GOXY1  WNPT   *
03626    00005       2560  XYOUT  DS    5,*-5*
```

```
 I-ADD OP              P/L LABEL    OP       OPERANDS

03632 J2 10923 0J000 2570          SM     XYCNTR,1000,08*
03644 J1 10917 000J0 2580          AM     YCNTR,10,010*
03656 M9 03404 00000 2590          B      G03,,0*
                     2600  * -DEL TAY    LARGER THAN DELTAX-*
03668 2Q 00096 10929 2610  YBIGER LD     96,ABSDX,1*
03680 2R 00097 10772 2620          D      97,ABSDY,1*
03692 32 00091 00000 2630          SF     91*
03704 K6 09587 00093 2640          TF     RATIO,93,0*
03716 M9 04040 00000 2650          B      OK,,0*
                     2660  * DELT AY L    ARGER THAN DELTAX*
03728 KO 10917 10843 2670          TF     YCNTR,DELTAY-1,01, SET YCOUNTER EQUAL TO DELTAY*
03740 KJ 10923 09587 2680  GO4     A      XYCNTR,RATIO,01,   MODIFY XYCOUNTER ADDING RATIO*
03752 ML 03992 10920 2690          BD     GOXY2,XYCNTR-3,01, TEST FOR DIGIT IN XYCOUNTER*
03764 38 00000 00200 2700          WNPT    *
03770    00005       2710  YOUT    DS     5,*-5*
03776 J2 10917 000-1 2720  GO5     SM     YCNTR,1,010*
03788 J4 10917 -0000 2730          CM     YCNTR,0,07,        TEST FOR LAST MOVE*
03800 M6 03740 01100 2740          BP     G04,,0*
                     2750  * -FIN AL A    DJUSTMENT IN THE X DIRECTION-*
03812 MM 03908 10338 2760          BNF    *&96,DELTAX,01,    TEST FOR NEGATIVE DELTAX*
                     2770  * -NEG ATIV    E DELTAX-*
03824 KM 10337 10910 2780          C      DELTAX-1,XCNTR-1,01,TEST FOR FINAL ADJUSTMENT*
03836 M6 05024 01200 2790          BE     CLEAR,,0*
03848 M7 03384 01300 2800          BN     *&36,,0*
03860 L8 10545 00200 2810          WNPT   SEVSO-1,,0*
03872 M9 05024 00000 2820          B      CLEAR,,0*
03884 L8 10189 00200 2830          WNPT   THREO-1,,0*
03896 M9 05024 00000 2840          B      CLEAR,,0*
                     2850  * -POS ITIV    E DELTAX-*
03908 KM 10337 10910 2860          C      DELTAX-1,XCNTR-1,01,TEST FOR FINAL ADJUSTMENT*
03920 M6 05024 01200 2870          BE     CLEAR,,0*
03932 M7 03968 01300 2880          BN     *&36,,0*
03944 L8 10189 00200 2890          WNPT   THREO-1,,0*
03956 M9 05024 00000 2900          B      CLEAR,,0*
03968 L8 10545 00200 2910          WNPT   SEVSO-1,,0*
03980 M6 05024 01200 2920          BE     CLEAR,,0*
                     2930  * -DIG IT I    N XYCOUNTER %DELTAY LARGER THAN DELTAX¤-*
03992 38 00000 00200 2940  GOXY2   WNPT    *
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I-ADD OP              P/L LABEL   OP       OPERANDS

04004 J2 10923 -1000 2950         SM     XYCNTR,1000,07*
04016 J1 10911 000J0 2960         AM     XCNTR,10,010*
04028 M9 03776 00000 2970         B      G05,,0*
                     2980 * -DEL  TAX    EQUAL TO DELTAY-*
04040 PJ 10835 10838 2990 OK      MF     DELTAX-3,DELTAX,01*
04052 J1 10838 000-5 3000         AM     DELTAX,5,010,       ROUND OFF DELTAX*
04064 J5 10838 00000 3010         TDM    DELTAX,0,0*
04076 PJ 10838 10835 3020         MF     DELTAX,DELTAX-3,01*
04088 KJ 09716 10838 3030         A      X0,DELTAX,01,       ADJUST X0*
04100 PJ 10841 10844 3040         MF     DELTAY-3,DELTAY,01*
04112 J1 10844 000-5 3050         AM     DELTAY,5,010,       ROUND OFF DELTAY*
04124 J5 10844 00000 3060         TDM    DELTAY,0,0*
04136 PJ 10844 10841 3070         MF     DELTAY,DELTAY-3,01*
04148 KJ 09722 10844 3080         A      Y0,DELTAY,01,       ADJUST Y0*
04160 KM 10837 10843 3090         C      DELTAX-1,DELTAY-1,01,TEST FOR LARGER INCREMENT*
04172 M7 03728 01300 3100         BN     G04-12,,0*
04184 M6 04208 01200 3110         BE     XYGO,,0*
04196 M9 03356 00000 3120         B      G02-12,,0*
                     3180 * DELT  AX E   QUAL TO DELTAY*
04208 KO 04358 03626 3190 XYGO    TF     FILL1,XYOUT,01*
04220 J2 03626 000J1 3200         SM     XYOUT,11,010*
04232 KO 04418 03626 3210         TF     FILL2,XYOUT,01*
04244 J2 03626 00J01 3220         SM     XYOUT,101,09*
04256 KO 04478 03626 3230         TF     FILL3,XYOUT,01*
04268 KO 04526 03626 3240         TF     FILL4,XYOUT,01*
04280 KO 10910 10837 3250         TF     XCNTR-1,DELTAX-1,01,SET XCOUNTER EQUAL TO DELTAX*
04292 ML 04508 10907 3260 FAST    BD     TENS,XCNTR-4,01,    TEST FOR DIGIT IN THE TENS POSITION*
04304 ML 04448 10908 3270         BD     UNITS,XCNTR-3,01,   TEST FOR DIGIT IN THE UNITS POSIT.*
04316 ML 04388 10909 3280         BD     TENTHS,XCNTR-2,01,  TEST FOR DIGIT IN THE 1/10 POSIT.*
04328 J4 10910 -0000 3290 LAST    CM     XCNTR-1,0,07,       TEST FOR LAST SINGLE MOVE*
04340 M7 05024 01100 3300         BNP    CLEAR,,0*
04352 38 00000 00200 3310         WNPT    *
04358    00005       3320 FILL1   DS     5,*-5*
04364 J2 10910 000-1 3330         SM     XCNTR-1,1,010*
04376 M9 04328 00000 3340         B      LAST,,0*
04388 J4 10909 0-000 3350 TENTHS  CM     XCNTR-2,0,08,       TEST FOR LAST 1/10 INCH MOVE*
04400 M7 04328 01100 3360         BNP    LAST,,0*
04412 38 00000 00200 3370         WNPT    *
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I-ADD OP              P/L LABEL   OP      OPERANDS

04418     00005       3380  FILL2   DS      5,*-5*
04424 J2  10909 000-1 3390          SM      XCNTR-2,1,010*
04436 M9  04388 00000 3400          B       TENTHS,,0*
04448 J4  10908 00-00 3410  UNITS   CM      XCNTR-3,0,09,       TEST FOR LAST ONE INCH MOVE*
04460 M7  04388 01100 3420          BNP     TENTHS,,0*
04472 38  00000 00200 3430          WNPT    *
04478     00005       3440  FILL3   DS      5,*-5*
04484 J2  10908 000-1 3450          SM      XCNTR-3,1,010*
04496 M9  04448 00000 3460          B       UNITS,,0*
04508 J2  10908 000-1 3470  TENS    SM      XCNTR-3,1,010*
04520 38  00000 00200 3480          WNPT    *
04526     00005       3490  FILL4   DS      5,*-5*
04532 M9  04292 00000 3500          B       FAST,,0*
                      3510  * -DEL  TAX     EQUAL ZERO-*
04544 KM  10772 10827 3520  NEXT5   C       ABSDY,TOLER,01,     TEST FOR ABSDY LESS THAN .005*
04556 M6  04580 01100 3530          BP      *&24,,0*
04568 M9  05024 00000 3540          B       CLEAR,,0*
04580 KM  10844 09706 3550          C       DELTAY,ZERO1,01,    TEST FOR DELTAY EQUAL ZERO*
04592 M6  04688 01100 3560          BP      NEXT55,,0*
                      3570  * -DEL  TAX     EQUAL ZERO AND NEGATIVE DELTAY-*
04604 JO  04358 J0417 3580          TFM     FILL1,FIVEO-1,017*
04616 JO  04418 J0406 3590          TFM     FILL2,FIVET-10,017*
04628 JO  04478 J0305 3600          TFM     FILL3,FIVEH-49,017*
04640 JO  04526 J0305 3610          TFM     FILL4,FIVEH-49,017*
04652 J2  10844 000-5 3620          SM      DELTAY,5,010,       ROUND OFF DELTAY*
04664 J5  10844 0000- 3630          TDM     DELTAY,,011*
04676 M9  04760 00000 3640          B       NEXTY,,0*
                      3650  * -DEL  TAX     EQUAL ZERO AND POSITIVE DELTAY-*
04688 JO  04358 -9961 3660  NEXT55  TFM     FILL1,ONESO-1,017*
04700 JO  04418 -9950 3670          TFM     FILL2,ONEST-10,017*
04712 JO  04478 -9849 3680          TFM     FILL3,ONESH-49,017*
04724 KO  04526 04478 3690          TF      FILL4,FILL3,01*
04736 J1  10844 000-5 3700          AM      DELTAY,5,010,       ROUND OFF DELTAY*
04748 J5  10844 00000 3710          TDM     DELTAY,0,0*
04760 KO  10910 10843 3720  NEXTY   TF      XCNTR -1,DELTAY-1,01,SET XCOUNTER EQUAL TO DELTAY*
04772 KJ  09722 10844 3730          A       YO,DELTAY,01,       ADJUST YO*
04784 M9  04292 00000 3740          B       FAST,,0*
                      3750  * -DEL  TAY     EQUAL ZERO-*
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I-ADD OP                P/L LABEL   OP      OPERANDS

04796 MM 04916 10838 3760  NEXT6   BNF     NEXT66,DELTAX,01,  TEST FOR NEGATIVE DELTAX*
                     3770  * -DEL  TAY     EQUAL ZERO AND NEGATIVE DELTAX-*
04808 J2 10838 000-5 3780          SM      DELTAX,5,010,      ROUND OFF DELTAX*
04820 J5 10838 0000- 3790          TDM     DELTAX,0,011*
04832 J0 04358 J0645 3800          TFM     FILL1,SEVSO-1,017*
04844 J0 04418 J0634 3810          TFM     FILL2,SEVST-10,017*
04856 J0 04478 J0533 3820          TFM     FILL3,SEVSH-49,017*
04868 K0 04526 04478 3830          TF      FILL4,FILL3,01*
04880 K0 10910 10837 3840          TF      XCNTR-1,DELTAX-1,01,SET XCOUNTER EQUAL TO DELTAX*
04892 KJ 09716 10838 3850          A       X0,DELTAX,01,      ADJUST X0*
04904 M9 04292 00000 3860          B       FAST,,0*
                     3870  * -DEL  TAY     EQUAL ZERO AND POSITIVE DELTAX-*
04916 J0 04358 J0189 3880  NEXT66  TFM     FILL1,THRE0-1,017*
04928 J0 04418 J0178 3890          TFM     FILL2,THRET-10,017*
04940 J0 04478 J0077 3900          TFM     FILL3,THREH-49,017*
04952 K0 04526 04478 3910          TF      FILL4,FILL3,01*
04964 J1 10838 000-5 3920          AM      DELTAX,5,010,      ROUND OFF DELTAX*
04976 J5 10838 00000 3930          TDM     DELTAX,0,0*
04988 K0 10910 10837 3940          TF      XCNTR-1,DELTAX-1,01,SET XCOUNTER EQUAL TO DELTAX*
05000 KJ 09716 10838 3950          A       X0,DELTAX,01,      ADJUST X0*
05012 M9 04292 00000 3960          B       FAST,,0*
                     3130  * -CLE  AR X    COUNTER AND YCOUNTER TO ZEROS AND SET XYCOUNTER #.005 -*
05024 26 09716 09728       CLEAR   TF      X0,X1*
05036 26 09722 09734               TF      Y0,Y1*
05048 J6 10923 -0005 3140          TFM     XYCNTR,5,07*
05060 26 10911 09706               TF      XCNTR,ZERO1*
05072 26 10917 09706               TF      YCNTR,ZERO1*
05084 43 05108 09748               BD      *&24,CNTR*
05096 49 02480 00000               B       READ*
05108 26 09600 09740               TF      MINU,X2*
05120 22 09600 09728               S       MINU,X1*
05132 33 09600 00000               CF      MINU*
05144 22 09600 09800               S       MINU,RR1*
05156 47 05180 01100               BNP     *&24*
05168 42 00000 00000               BB      *
05180 26 09600 09746               TF      MINU,Y2*
05192 22 09600 09734               S       MINU,Y1*
05204 33 09600 00000               CF      MINU*
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I-ADD OP              P/L LABEL   OP      OPERANDS

05216 22 09600 09800              S       MINU,RR1*
05228 47 06572 01100              BNP     END*
05240 42 00000 00000              BB       *
05252 16 09748 000-1        CIRCLE TFM    CNTR,1,10*
05264 26 09499 09640               TF     FLTING,A&19*
05276 17 09272 000-0 01100         BTM    FLTOFX,0,10*
05288 32 09500 00000 01109         SF     FIXED-14*
05300 26 09606 09505 01110         TF     XC,FIXED-9*
05312 71 09606 09506 01120         MF     XC,FIXED-8*
05324 26 09499 09650 01130         TF     FLTING,A&29*
05336 17 09272 000-0 01140         BTM    FLTOFX,0,10*
05348 32 09500 00000 01149         SF     FIXED-14*
05360 26 09612 09505 01150         TF     YC,FIXED-9*
05372 71 09612 09506 01160         MF     YC,FIXED-8*
05384 26 09499 09660 01170         TF     FLTING,A&39*
05396 17 09272 000-0 01180         BTM    FLTOFX,0,10*
05408 32 09500 00000 01189         SF     FIXED-14*
05420 26 09618 09505 01190         TF     RADIUS,FIXED-9*
05432 71 09618 09506 01200         MF     RADIUS,FIXED-8*
05444 47 05600 00100 01250         BNC1   TABLE-12*
05456 23 09606 09710 01260         M      XC,SCALE*
05468 32 00092 00000 02010         SF     92*
05480 26 09606 00097 02020         TF     XC,97*
05492 71 09606 00099 02030         MF     XC,99*
05504 23 09612 09710 02040         M      YC,SCALE*
05516 32 00092 00000 02050         SF     92*
05528 26 09612 00097 02060         TF     YC,97*
05540 71 09612 00099 02070         MF     YC,99*
05552 23 09618 09710 02080         M      RADIUS,SCALE*
05564 32 00092 00000 02090         SF     92*
05576 26 09618 00097 02100         TF     RADIUS,97*
05588 71 09618 00099 02110         MF     RADIUS,99*
05600 26 09620 09625               TF     M,A&4*
05612 16 05647 -9752        TABLE  TFM    TABLE&35,R0*
05624 16 05666 -9794               TFM    TABLE&54,RR0*
05636 23 09618 09752               M      RADIUS,R0*
05648 32 00091 00000               SF     91*
05660 26 09794 00096               TF     RR0,96*
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I-ADD OP              P/L LABEL   OP      OPERANDS

05672 11 05647 000-4              AM      TABLE&35,4,10*
05684 11 05666 000-6              AM      TABLE&54,6,10*
05696 14 05666 -9848              CM      TABLE&54,RR9*
05708 47 05636 01100              BNP     TABLE&24*
05720 36 09621 00500              RNCD    A*
05732 14 09622 000-5 02130        CM      A&1,5,10*
05744 46 05792 01200 02140        BE      *&48*
05756 39 09539 00100 02150        WATY    CARD*
05768 48 00000 00000 02160        H        *
05780 49 02000 00000 02170        B       START*
05792 26 09499 09640 02180        TF      FLTING,A&19*
05804 17 09272 000-0 02190        BTM     FLTOFX,0,10*
05816 32 09500 00000 02199        SF      FIXED-14*
05828 26 09740 09505 02200        TF      X2,FIXED-9*
05840 71 09740 09506 02210        MF      X2,FIXED-8*
05852 26 09499 09650 02220        TF      FLTING,A&29*
05864 17 09272 000-0 02230        BTM     FLTOFX,0,10*
05876 32 09500 00000 02239        SF      FIXED-14*
05888 26 09746 09505 02240        TF      Y2,FIXED-9*
05900 71 09746 09506 02250        MF      Y2,FIXED-8*
05912 47 06020 00100              BNC1    DP2*
05924 23 09740 09710 03010        M       X2,SCALE*
05936 32 00092 00000 03020        SF      92*
05948 26 09740 00097 03030        TF      X2,97*
05960 71 09740 00099 03040        MF      X2,99*
05972 23 09746 09710 03050        M       Y2,SCALE*
05984 32 00092 00000 03060        SF      92*
05996 26 09746 00097 03070        TF      Y2,97*
06008 71 09746 00099 03080        MF      Y2,99*
06020 26 09600 09740        DP2   TF      MINU,X2*
06032 22 09600 09716              S       MINU,X0*
06044 33 09600 00000              CF      MINU*
06056 22 09600 09800              S       MINU,RR1*
06068 47 06092 01100              BNP     *&24*
06080 49 06152 00000              B       ONWRD*
06092 26 09600 09746              TF      MINU,Y2*
06104 22 09600 09722              S       MINU,Y0*
06116 33 09600 00000              CF      MINU*
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I-ADD OP              P/L LABEL   OP      OPERANDS

06128 22 09600 09800              S       MINU,RR1*
06140 47 06572 01100              BNP     END*
06152 44 06368 09620        ONWRD BNF     CCW,M*
06164 26 09600 09606        CW    TF      MINU,XC*
06176 22 09600 09716              S       MINU,X0*
06188 46 06260 01100              BP      CW&96*
06200 46 06308 01200              BE      CW&144*
06  2 26 09600 09612              TF      MINU,YC*
06  4 22 09600 09722              S       MINU,Y0*
06236 46 07340 01300              BNN     SCW4*
06248 49 07880 00000              B       SCW1*
06260 26 09600 09612              TF      MINU,YC*
06272 22 09600 09722              S       MINU,Y0*
06284 46 07520 01100              BP      SCW3*
06296 49 07700 00000              B       SCW2*
06308 26 09600 09612              TF      MINU,YC*
06320 22 09600 09722              S       MINU,Y0*
06332 46 07520 01100              BP      SCW3*
06344 46 06572 01200              BE      END*
06356 49 07880 00000              B       SCW1*
06368 26 09600 09606        CCW   TF      MINU,XC*
06380 22 09600 09716              S       MINU,X0*
06392 46 06464 01100              BP      CCW&96*
06404 46 06512 01200              BE      CCW&144*
06416 26 09600 09612              TF      MINU,YC*
06428 22 09600 09722              S       MINU,Y0*
06440 46 07160 01100              BP      SCCW4*
06452 49 06620 00000              B       SCCW1*
06464 26 09600 09612              TF      MINU,YC*
06476 22 09600 09722              S       MINU,Y0*
06488 47 06800 01300              BN      SCCW2*
06500 49 06980 00000              B       SCCW3*
06512 26 09600 09612              TF      MINU,YC*
06524 22 09600 09722              S       MINU,Y0*
06536 46 07160 01100              BP      SCCW4*
06548 46 06572 01200              BE      END*
06560 49 06800 00000              B       SCCW2*
06572 16 09748 000-0        END   TFM     CNTR,0,10*
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I-ADD OP                P/L LABEL   OP      OPERANDS

06584 26 09728 09740            TF      X1,X2*
06596 26 09734 09746            TF      Y1,Y2*
06608 49 02756 00000            B       NEXT1*
06620 16 08647 -9848        SCCW1   TFM     CCW1&47,RR9*
06632 16 08671 -9794            TFM     CCW1&71,RR0*
06644 16 06775 -9752            TFM     SCCW1&155,R0*
06656 26 09600 09722            TF      MINU,Y0*
06668 22 09600 09612            S       MINU,YC*
06680 28 00096 09600            LD      96,MINU*
06692 29 00091 09618            D       91,RADIUS*
06704 33 00093 00000            CF      93*
06716 32 00090 00000            SF      90*
06728 11 06775 000-4            AM      SCCW1&155,4,10*
06740 12 08647 000-6            SM      CCW1&47,6,10*
06752 11 08671 000-6            AM      CCW1&71,6,10*
06764 24 00093 09756            C       93,R1*
06776 47 08624 01100            BNP     CCW1&24*
06788 49 06728 00000            B       *-60*
06800 16 08779 -9794        SCCW2   TFM     CCW2&47,RR0*
06812 16 08803 -9848            TFM     CCW2&71,RR9*
06824 16 06955 -9788            TFM     SCCW2&155,R9*
06836 26 09600 09722            TF      MINU,Y0*
06848 22 09600 09612            S       MINU,YC*
06860 28 00096 09600            LD      96,MINU*
06872 29 00091 09618            D       91,RADIUS*
06884 33 00093 00000            CF      93*
06896 32 00090 00000            SF      90*
06908 12 06955 000-4            SM      SCCW2&155,4,10*
06920 11 08779 000-6            AM      CCW2&47,6,10*
06932 12 08803 000-6            SM      CCW2&71,6,10*
06944 24 00093 09784            C       93,R8*
06956 46 08756 01300            BNN     CCW2&24*
06968 49 06908 00000            B       *-60*
06980 16 08911 -9848        SCCW3   TFM     CCW3&47,RR9*
06992 16 08935 -9794            TFM     CCW3&71,RR0*
07004 16 07135 -9752            TFM     SCCW3&155,R0*
07016 26 09600 09722            TF      MINU,Y0*
07028 22 09600 09612            S       MINU,YC*
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I-ADD OP              P/L LABEL   OP      OPERANDS

07040 28 00096 09600              LD      96,MINU*
07052 29 00091 09618              D       91,RADIUS*
07064 33 00093 00000              CF      93*
07076 32 00090 00000              SF      90*
07088 11 07135 000-4              AM      SCCW3&155,4,10*
07100 12 08911 000-6              SM      CCW3&47,6,10*
07112 11 08935 000-6              AM      CCW3&71,6,10*
07124 24 00093 09756              C       93,R1*
07136 47 08868 01100              BNP     CCW3&24*
07148 49 07088 00000              B       *-60*
07160 16 09043 -9794        SCCW4 TFM     CCW4&47,RR0*
07172 16 09067 -9848              TFM     CCW4&71,RR9*
07184 16 07315 -9788              TFM     SCCW4&155,R9*
07196 26 09600 09722              TF      MINU,Y0*
07208 22 09600 09612              S       MINU,YC*
07220 28 00096 09600              LD      96,MINU*
07232 29 00091 09618              D       91,RADIUS*
07244 33 00093 00000              CF      93*
07256 32 00090 00000              SF      90*
07268 12 07315 000-4              SM      SCCW4&155,4,10*
07280 11 09043 000-6              AM      CCW4&47,6,10*
07292 12 09067 000-6              SM      CCW4&71,6,10*
07304 24 00093 09784              C       93,R8*
07316 46 09020 01300              BNN     CCW4&24*
07328 49 07268 00000              B       *-60*
07340 16 08107 -9848        SCW4  TFM     CW4&47,RR9*
07352 16 08131 -9794              TFM     CW4&71,RR0*
07364 16 07495 -9752              TFM     SCW4&155,R0*
07376 26 09600 09722              TF      MINU,Y0*
07388 22 09600 09612              S       MINU,YC*
07400 28 00096 09600              LD      96,MINU*
07412 29 00091 09618              D       91,RADIUS*
07424 33 00093 00000              CF      93*
07436 32 00090 00000              SF      90*
07448 11 07495 000-4              AM      SCW4&155,4,10*
07460 12 08107 000-6              SM      CW4&47,6,10*
07472 11 08131 000-6              AM      CW4&71,6,10*
07484 24 00093 09756              C       93,R1*
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I-ADD OP              P/L LABEL   OP      OPERANDS

07496 47 08084 01100              BNP     CW4&24*
07508 49 07448 00000              B       *-60*
07520 16 08239 -9794        SCW3  TFM     CW3&47,RR0*
07532 16 08263 -9848              TFM     CW3&71,RR9*
07544 16 07675 -9788              TFM     SCW3&155,R9*
07556 26 09600 09722              TF      MINU,Y0*
07568 22 09600 09612              S       MINU,YC*
07580 28 00096 09600              LD      96,MINU*
07592 29 00091 09618              D       91,RADIUS*
07604 33 00093 00000              CF      93*
07616 32 00090 00000              SF      90*
07628 12 07675 000-4              SM      SCW3&155,4,10*
07640 11 08239 000-6              AM      CW3&47,6,10*
07652 12 08263 000-6              SM      CW3&71,6,10*
07664 24 00093 09784              C       93,R8*
07676 46 08216 01300              BNN     CW3&24*
07688 49 07628 00000              B       *-60*
07700 16 08371 -9848        SCW2  TFM     CW2&47,RR9*
07712 16 08395 -9794              TFM     CW2&71,RR0*
07724 16 07855 -9752              TFM     SCW2&155,R0*
07736 26 09600 09722              TF      MINU,Y0*
07748 22 09600 09612              S       MINU,YC*
07760 28 00096 09600              LD      96,MINU*
07772 29 00091 09618              D       91,RADIUS*
07784 33 00093 00000              CF      93*
07796 32 00090 00000              SF      90*
07808 11 07855 000-4              AM      SCW2&155,4,10*
07820 12 08371 000-6              SM      CW2&47,6,10*
07832 11 08395 000-6              AM      CW2&71,6,10*
07844 24 00093 09756              C       93,R1*
07856 47 08348 01100              BNP     CW2&24*
07868 49 07808 00000              B       *-60*
07880 16 08503 -9794        SCW1  TFM     CW1&47,RR0*
07892 16 08527 -9848              TFM     CW1&71,RR9*
07904 16 08035 -9788              TFM     SCW1&155,R9*
07916 26 09600 09722              TF      MINU,Y0*
07928 22 09600 09612              S       MINU,YC*
07940 28 00096 09600              LD      96,MINU*
```

```
I-ADD OP              P/L LABEL   OP      OPERANDS

07952 29 00091 09618              D       91,RADIUS*
07964 33 00093 00000              CF      93*
07976 32 00090 00000              SF      90*
07988 12 08035 000-4              SM      SCW1&155,4,10*
08000 11 08503 000-6              AM      CW1&47,6,10*
08012 12 08527 000-6              SM      CW1&71,6,10*
08024 24 00093 09784              C       93,R8*
08036 46 08480 01300              BNN     CW1&24*
08048 49 07988 00000              B       *-60*
08060 16 08107 -9842        CW4   TFM     CW4&47,RR8*
08072 16 08131 -9800              TFM     CW4&71,RR1*
08084 26 09728 09606              TF      X1,XC*
08096 21 09728 09842              A       X1,RR8*
08108 26 09734 09612              TF      Y1,YC*
08120 22 09734 09800              S       Y1,RR1*
08132 17 02756 000-0              BTM     NEXT1,0,10*
08144 12 08107 000-6              SM      CW4&47,6,10*
08156 11 08131 000-6              AM      CW4&71,6,10*
08168 14 08131 -9848              CM      CW4&71,RR9*
08180 47 08084 01100              BNP     CW4&24*
08192 16 08239 -9800        CW3   TFM     CW3&47,RR1*
08204 16 08263 -9842              TFM     CW3&71,RR8*
08216 26 09728 09606              TF      X1,XC*
08228 22 09728 09800              S       X1,RR1*
08240 26 09734 09612              TF      Y1,YC*
08252 22 09734 09842              S       Y1,RR8*
08264 17 02756 000-0              BTM     NEXT1,0,10*
08276 11 08239 000-6              AM      CW3&47,6,10*
08288 12 08263 000-6              SM      CW3&71,6,10*
08300 14 08239 -9848              CM      CW3&47,RR9*
08312 47 08216 01100              BNP     CW3&24*
08324 16 08371 -9842        CW2   TFM     CW2&47,RR8*
08336 16 08395 -9800              TFM     CW2&71,RR1*
08348 26 09728 09606              TF      X1,XC*
08360 22 09728 09842              S       X1,RR8*
08372 26 09734 09612              TF      Y1,YC*
08384 21 09734 09800              A       Y1,RR1*
08396 17 02756 000-0              BTM     NEXT1,0,10*
```

```
I-ADD OP                P/L LABEL   OP      OPERANDS

08408 12 08371 000-6            SM      CW2&47,6,10*
08420 11 08395 000-6            AM      CW2&71,6,10*
08432 14 08395 -9848            CM      CW2&71,RR9*
08444 47 08348 01100            BNP     CW2&24*
08456 16 08503 -9800        CW1 TFM     CW1&47,RR1*
08468 16 08527 -9842            TFM     CW1&71,RR8*
08480 26 09728 09606            TF      X1,XC*
08492 21 09728 09800            A       X1,RR1*
08504 26 09734 09612            TF      Y1,YC*
08516 21 09734 09842            A       Y1,RR8*
08528 17 02756 000-0            BTM     NEXT1,0,10*
08540 11 08503 000-6            AM      CW1&47,6,10*
08552 12 08527 000-6            SM      CW1&71,6,10*
08564 14 08503 -9848            CM      CW1&47,RR9*
08576 47 08480 01100            BNP     CW1&24*
08588 49 08060 00000            B       CW4*
08600 16 08647 -9842        CCW1 TFM    CCW1&47,RR8*
08612 16 08671 -9800            TFM     CCW1&71,RR1*
08624 26 09728 09606            TF      X1,XC*
08636 21 09728 09842            A       X1,RR8*
08648 26 09734 09612            TF      Y1,YC*
08660 21 09734 09800            A       Y1,RR1*
08672 17 02756 000-0            BTM     NEXT1,0,10*
08684 12 08647 000-6            SM      CCW1&47,6,10*
08696 11 08671 000-6            AM      CCW1&71,6,10*
08708 14 08671 -9848            CM      CCW1&71,RR9*
08720 47 08624 01100            BNP     CCW1&24*
08732 16 08779 -9800        CCW2 TFM    CCW2&47,RR1*
08744 16 08803 -9842            TFM     CCW2&71,RR8*
08756 26 09728 09606            TF      X1,XC*
08768 22 09728 09800            S       X1,RR1*
08780 26 09734 09612            TF      Y1,YC*
08792 21 09734 09842            A       Y1,RR8*
08804 17 02756 000-0            BTM     NEXT1,0,10*
08816 11 08779 000-6            AM      CCW2&47,6,10*
08828 12 08803 000-6            SM      CCW2&71,6,10*
08840 14 08779 -9848            CM      CCW2&47,RR9*
08852 47 08756 01100            BNP     CCW2&24*
```

```
I-ADD OP                P/L LABEL   OP      OPERANDS

08864 16 08911 -9842        CCW3    TFM     CCW3&47,RR8*
08876 16 08935 -9800                TFM     CCW3&71,RR1*
08888 26 09728 09606                TF      X1,XC*
08900 22 09728 09842                S       X1,RR8*
08912 26 09734 09612                TF      Y1,YC*
08924 22 09734 09800                S       Y1,RR1*
08936 17 02756 000-0                BTM     NEXT1,0,10*
08948 12 08911 000-6                SM      CCW3&47,6,10*
08960 11 08935 000-6                AM      CCW3&71,6,10*
08972 14 08935 -9848                CM      CCW3&71,RR9*
08984 47 08888 01100                BNP     CCW3&24*
08996 16 09043 -9800        CCW4    TFM     CCW4&47,RR1*
09008 16 09067 -9842                TFM     CCW4&71,RR8*
09020 26 09728 09606                TF      X1,XC*
09032 21 09728 09800                A       X1,RR1*
09044 26 09734 09612                TF      Y1,YC*
09056 22 09734 09842                S       Y1,RR8*
09068 17 02756 000-0                BTM     NEXT1,0,10*
09080 11 09043 000-6                AM      CCW4&47,6,10*
09092 12 09067 000-6                SM      CCW4&71,6,10*
09104 14 09043 -9848                CM      CCW4&47,RR9*
09116 47 09020 01100                BNP     CCW4&24*
09128 49 08600 00000                B       CCW1*
09140 14 09622 000-3 01010  CHECK   CM      A&1,03,10*
09152 47 09200 01200 01020          BNE     CHECK1*
09164 38 10765 00200 01030          WNPT    PENUP-1*
09176 48 00000 00000 01040          H        *
09188 49 02000 00000 01050          B       START*
09200 14 09622 000-6 01060  CHECK1  CM      A&1,06,10*
09212 47 09236 01200 01070          BNE     CHECK2*
09224 49 05252 00000 01080          B       CIRCLE*
09236 14 09622 000-4 01081  CHECK2  CM      A&1,4,10*
09248 47 02480 01200 01082          BNE     READ*
09260 49 09164 00000 01083          B       CHECK&24*
09272 26 09506 09521 16020  FLTOFX  TF      FIXED-8,ZERO*
09284 14 09491 000M7 16030          CM      FLTING-8,47,10*
09296 47 09488 01300 16040          BL      FFEXIT*
09308 14 09491 000N4 16050          CM      FLTING-8,54,10*
```

```
I-ADD OP              P/L LABEL   OP      OPERANDS

09320 47 09392 01300 16060        BL     *&72*
09332 16 09535 -5771 16070        TFM    ERROR&12,5771*
09344 34 00000 00102 16071        RCTY    *
09356 39 09523 00100 16080        WATY   ERROR*
09368 48 00000 00000 16090        H       *
09380 49 02000 00000 16100        B      START*
09392 16 09482 -9553 16110        TFM    FFEXIT-6,FIXED&39*
09404 22 09482 09491 16120        S      FFEXIT-6,FLTING-8*
09416 44 09464 09499 16130        BNF    *&48,FLTING*
09428 16 09458 -9445 16140        TFM    *&30,FLTING-54*
09440 21 09458 09491 16150        A      *&18,FLTING-8*
09452 32 00000 00000 16160        SF      *
09462    00001       16170 RM     DC     1,@,*-1*
16170*                                                    -6-9462-9463-
09464 25 09499 09462 16180        TD     FLTING,RM*
09476 31 00000 09492 16190        TR     0,FLTING-7*
09488 42 00000 00000 16200 FFEXIT BB      *
09499    00010       16210 FLTING DS     10,**
09514    00015       16220 FIXED  DS     15*
09521    00007       16230 ZERO   DC     7,0*
16230-000000*                                             -6-9515-9522-
09523    00008       16240 ERROR  DAC    8,ERR    @,,ERRP1 PRINTED IF NO. IS LARGER THAN 1000*
16240M55959000000000*                                     -6-9522-9538-
09539    00021             CARD   DAC    21,CARD AFTER 06 NOT 05@*
00000M341594400414663455900707600555663007075O*           -6-9538-9580-
09587    00008             RATIO  DS     8*
09600    00013       07060 MINU   DS     13*
09606    00006       07010 XC     DS     6*
09612    00006       07020 YC     DS     6*
09618    00006       07030 RADIUS DS     6*
09620    00002       07040 M      DS     2*
09621    00001             A      DS     1*
09700    00079                    DS     79*
09706    00006             ZERO1  DC     6,0*
00000-00000*                                              -6-9701-9707-
09710    00004             SCALE  DS     4*
09716    00006             XO     DS     6*
09722    00006             YO     DS     6*
```

```
I-ADD OP              P/L LABEL   OP      OPERANDS

09728    00006            X1      DS      6*
09734    00006            Y1      DS      6*
09740    00006            X2      DS      6*
09746    00006            Y2      DS      6*
09748    00002            CNTR    DS      2*
09752    00004            R0      DC      4,0*
00000-000*                                          -6-9749-9753-
09756    00004            R1      DC      4,174*
00000-174*                                          -6-9753-9757-
09760    00004            R2      DC      4,342*
00000-342*                                          -6-9757-9761-
09764    00004            R3      DC      4,500*
00000-500*                                          -6-9761-9765-
09768    00004            R4      DC      4,643*
00000-643*                                          -6-9765-9769-
09772    00004            R5      DC      4,766*
00000-766*                                          -6-9769-9773-
09776    00004            R6      DC      4,866*
00000-866*                                          -6-9773-9777-
09780    00004            R7      DC      4,940*
00000-940*                                          -6-9777-9781-
09784    00004            R8      DC      4,985*
00000-985*                                          -6-9781-9785-
09788    00004            R9      DC      4,1000*
00000J000*                                          -6-9785-9789-
09794    00006            RR0     DS      6*
09800    00006            RR1     DS      6*
09806    00006            RR2     DS      6*
09812    00006            RR3     DS      6*
09818    00006            RR4     DS      6*
09824    00006            RR5     DS      6*
09830    00006            RR6     DS      6*
09836    00006            RR7     DS      6*
09842    00006            RR8     DS      6*
09848    00006            RR9     DS      6*
09898    00050            ONESH   DC      50,1111111111111111111111111111111111111111111111111*
00000J1111111111111111111111111111111111111111111111111*          -6-9849-9899-
09948    00050                    DC      50,1111111111111111111111111111111111111111111111111*
```

```
I-ADD OP              P/L LABEL   OP       OPERANDS

00000J1111111111111111111111111111111111111111111111111*       -6-9899-9949-
09949    00001                        DC     1,@*
00000*                                                          -6-9949-9950-
09960    00011              ONEST     DC     11,1111111111@*
00000J111111111*                                                -6-9950-9961-
09962    00002              ONESO     DC     2,1@*
00000J*                                                         -6-9961-9963-
10012    00050              TWOSH     DC     50,22222222222222222222222222222222222222222222222222*
00000K22222222222222222222222222222222222222222222222*         -6-9963J0013-
10062    00050                        DC     50,222222222222222222222222222222222222222222222222222*
00000K22222222222222222222222222222222222222222222222*         -6J0013J0063-
10063    00001                        DC     1,@*
00000*                                                          -6J0063J0064-
10074    00011              TWOST     DC     11,2222222222@*
00000K222222222*                                                -6J0064J0075-
10076    00002              TWOSO     DC     2,2@*
00000K*                                                         -6J0075J0077-
10126    00050              THREH     DC     50,33333333333333333333333333333333333333333333333333*
00000L33333333333333333333333333333333333333333333333*         -6J0077J0127-
10176    00050                        DC     50,33333333333333333333333333333333333333333333333333*
00000L33333333333333333333333333333333333333333333333*         -6J0127J0177-
10177    00001                        DC     1,@*
00000*                                                          -6J0177J0178-
10188    00011              THRET     DC     11,3333333333@*
00000L333333333*                                                -6J0178J0189-
10190    00002              THREO     DC     2,3@*
00000L*                                                         -6J0189J0191-
10240    00050              FOURH     DC     50,44444444444444444444444444444444444444444444444444*
00000M44444444444444444444444444444444444444444444444*         -6J0191J0241-
10290    00050                        DC     50,44444444444444444444444444444444444444444444444444*
00000M44444444444444444444444444444444444444444444444*         -6J0241J0291-
10291    00001                        DC     1,@*
00000*                                                          -6J0291J0292-
10302    00011              FOURT     DC     11,4444444444@*
00000M444444444*                                                -6J0292J0303-
10304    00002              FOURO     DC     2,4@*
00000M*                                                         -6J0303J0305-
10354    00050              FIVEH     DC     50,55555555555555555555555555555555555555555555555555*
```

```
I-ADD OP              P/L LABEL   OP       OPERANDS

00000N55555555555555555555555555555555555555555555*      -6J0305J0355-
10404     00050                   DC     50,55555555555555555555555555555555555555555555555555*
00000N555555555555555555555555555555555555555555555*      -6J0355J0405-
10405     00001                   DC     1,a*
00000*                                                     -6J0405J0406-
10416     00011             FIVET DC     11,5555555555a*
00000N555555555*                                           -6J0406J0417-
10418     00002             FIVEO DC     2,5a*
00000N*                                                    -6J0417J0419-
10468     00050             SIXSH DC     50,66666666666666666666666666666666666666666666666666*
0000006666666666666666666666666666666666666666666666*      -6J0419J0469-
10518     00050                   DC     50,66666666666666666666666666666666666666666666666666*
0000006666666666666666666666666666666666666666666666*      -6J0469J0519-
10519     00001                   DC     1,a*
00000*                                                     -6J0519J0520-
10530     00011             SIXST DC     11,6666666666a*
0000006666666666*                                          -6J0520J0531-
10532     00002             SIXSO DC     2,6a*
000000*                                                    -6J0531J0533-
10582     00050       -     SEVSH DC     50,77777777777777777777777777777777777777777777777777*
00000P77777777777777777777777777777777777777777777777*    -6J0533J0583-
10632     00050                   DC     50,77777777777777777777777777777777777777777777777777*
00000P77777777777777777777777777777777777777777777777*    -6J0583J0633-
10633     00001                   DC     1,a*
00000*                                                     -6J0633J0634-
10644     00011             SEVST DC     11,7777777777a*
00000P7777777777*                                          -6J0634J0645-
10646     00002             SEVSO DC     2,7a*
00000P*                                                    -6J0645J0647-
10696     00050             EIGHH DC     50,88888888888888888888888888888888888888888888888888*
00000Q8888888888888888888888888888888888888888888888*      -6J0647J0697-
10746     00050                   DC     50,88888888888888888888888888888888888888888888888888*
00000Q8888888888888888888888888888888888888888888888*      -6J0697J0747-
10747     00001                   DC     1,a*
00000*                                                     -6J0747J0748-
10758     00011             EIGHT DC     11,8888888888a*
00000Q8888888888*                                          -6J0748J0759-
10760     00002             EIGHO DC     2,8a*
```

```
I-ADD OP                P/L LABEL   OP      OPERANDS

000000*                                                          -6J0759J0761-
10763    00003              PENDWN DC    3,00@*
00000-0*                                                         -6J0761J0764-
10766    00003              PENUP  DC    3,09@*
00000-9*                                                         -6J0764J0767-
10772    00006        4490  ABSDY  DS    6,,,                 ABSOLUTE VALUE OF DELTAY*
10774    00002        4530  EX2    DC    2,2*
45300-2*                                                         -6J0773J0775-
10776    00002        4540  EX0    DC    2,0*
45400-0*                                                         -6J0775J0777-
10778    00002        4550  EX     DC    2,-9-9*
45500RR*                                                         -6J0777J0779-
10780    00002        4560  EXM2   DC    2,-2*
45600-K*                                                         -6J0779J0781-
10786    00006        4570  AX     DS    6,,,                 INITIAL ADRESS OF X*
10792    00006        4580  AY     DS    6,,,                 INITIAL ADRESS OF Y*
00060    00003        4590  FAC    DS    3,60,,               FLOATING POINT ACCUMULATOR*
59829    00004        4600  ARG    DS    4,59829,,                 ARGUMENT*
10794    00002        4610  FF     DC    2,8,,                FLOATING POINT FIELD LENGTH*
46100-8*                                                         -6J0793J0795-
10824    00030        4620  Y      DC    30,0*
46200-000000000030000000000000000000*                            -6J0795J0825-
10827    00003        4630  TOLER  DC    3,5,,                TOLERENCE OF .005 INCH*
46300-05*                                                        -6J0825J0828-
10832    00005        4640  CO     DC    5,0*
46400-0000*                                                      -6J0828J0833-
10838    00006              DELTAX DS    6*
10844    00006              DELTAY DS    6*
10847    00018              MES1   DAC   18,FIRST CARD NOT 05@*
00000M64959626300434159440055566300707 50*                       -6J0846J0882-
10883    00012              MES2   DAC   12,ENTER SCALE@*
00000M55563455900624341534 50*                                   -6J0882J0906-
10911    00006              XCNTR  DS    6*
10917    00006              YCNTR  DS    6*
10923    00006              XYCNTR DS    6*
10929    00006        4480  ABSDX  DS    6,,,                 ABSOLUTE VALUE OF DELTAX*
02000                        DEND   START*
00000  L60000000500490000 0*                                     -8-0096-0115-
```

```
 I-ADD OP                P/L LABEL   OP       OPERANDS

3600100005003600172005003600244005003600316005003600000005 00                -
0000000000031020304000204060800030609021004080216100500151020060218142004 -
7041128200806142230090817263000000000050607080900121416181518112427202424 -
8223635203530454036324844553249465360484654627544536271801234567891234564 -
789-23456789-J3456789-JK456789-JKL56789-JKLM6789-JKLMN789-JKLMN089-JKLMN4 -
M8000000000049-20000P9-JKLMNOPQ4     L10038800019M900000000000M900003600000  -
```

Appendix E

AUTOMAP POST PROCESSOR
FOR GE MARK CENTURY DIRECTOR

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OPERATING INSTRUCTIONS	E-1
NESTING	E-2
DATA FLOW	E-3
SPECIAL CONSIDERATIONS	E-6
SAMPLE PROBLEM FOR POST PROCESSOR - INPUT DATA	E-7
SAMPLE PROBLEM FOR POST PROCESSOR - OUTPUT DATA	E-8
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PROGRAM LISTING	E-21

Appendix E

AUTOMAP POST PROCESSOR FOR GE MARK CENTURY DIRECTOR

This program is the final step in the AUTOMAP system. It accepts as input the output of Phase II AUTOMAP, and prepares punched paper tape for use with the General Electric Company's Mark Century director on the Air Reduction Company's Tape-O-Graph flame cutting machine. This Appendix includes operating instruction, discussion of the nesting technique, instructions for preparing nesting header cards, some special considerations, sample problem, flow chart, and program listing.

I. OPERATING INSTRUCTIONS

A. Clear memory
   1. Reset - Insert
   2. Type 26 00002 00003, R-S
   3. After 5 seconds, push instant stop

B. Load Program
   1. Push reset
   2. Place post-processor program deck in Read Hopper
   3. Push load key on reader
   4. Push reader start to read last two cards
   5. Parity SW and I/O SW to stop, o'flow to program

C. Operating Program
   1. Ready paper tape punch
   2. Program switch settings

      SW-1 On - output is printed on typewriter, Off - not printed

      SW-2 On - output is punched on paper tape, Off - not punched

SW-3 On - Tape punch will prepare a 3" blank segment of tape for a hand-written label. Type in title followed by record mark.

Example: Part 3052 Tape 1 *

Release - start

Tape punch will enter title in coded format directly following the blank area.

Run about two inches of tape to separate title from machine tool instructions

Sw-4 On - totals for length of path, cutting time and sum of ΔX, ΔY motions are printed for each part and for all parts (if last part has a "FINI" card), Off - no totals

3. Load data deck (Phase 2 Output)
4. Press reader start and computer start
5. Error messages are self-explanatory, with the exception of Err P1, which means that a number larger than 1000 was entered.

II. NESTING

A. When nesting, a special header card must be prepared for each program to provide the post processing program with certain information. (See Fig. E-1.) The information required tells the post-processor how much a particular part is to be rotated and translated, and if reflection about a horizontal axis is desired. The information is in the form of any two known points (X and Y coordinates for each) on the original part, and three of the four coordinates for the same two points on the transformed part). The reason one of the transformed coordinates is omitted is that, in giving the coordinates of two points on the original part, a distance between them is implied and this distance must be carried over to the points on the transformed part. This is accomplished by letting the nesting routine calculate one of the coordinates on the

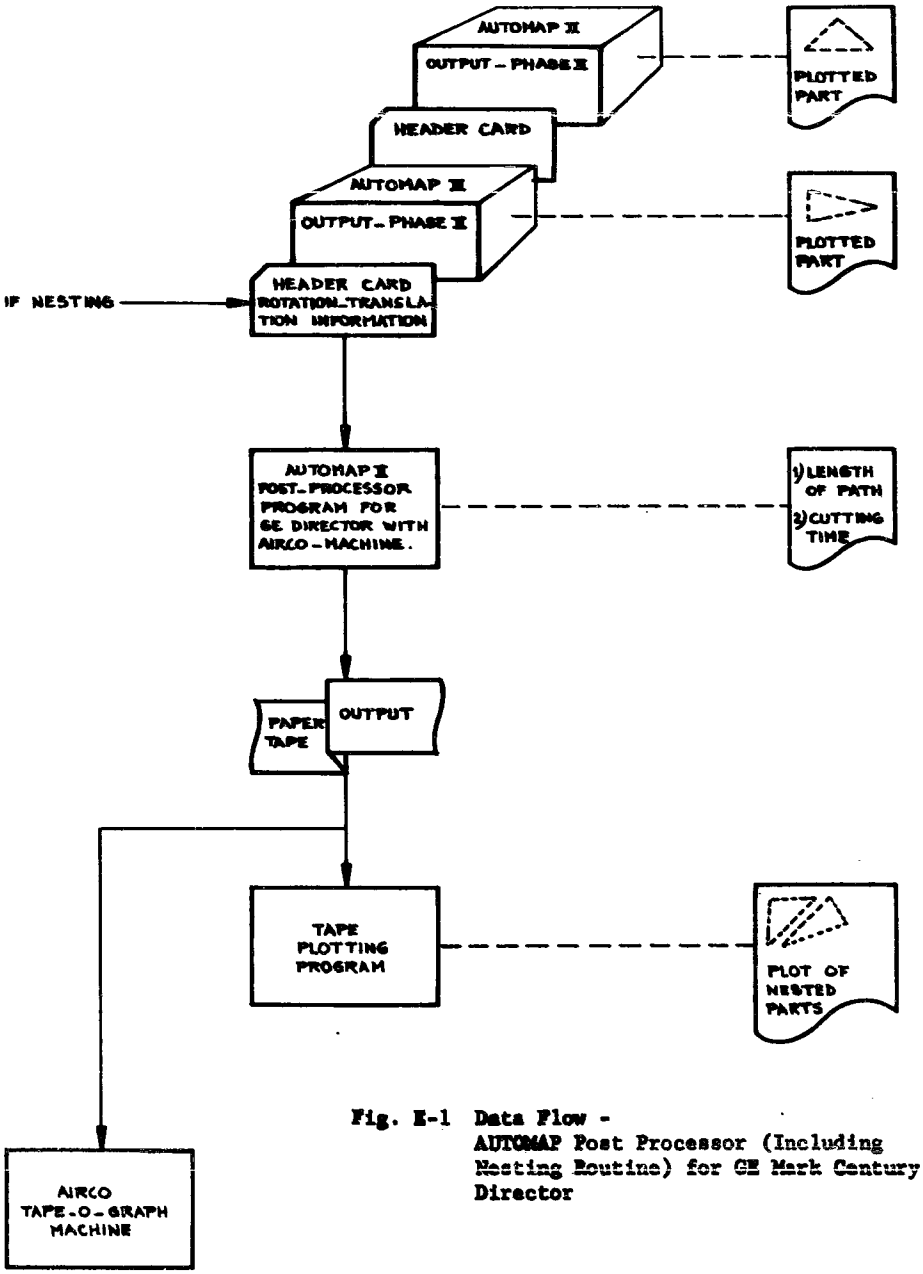
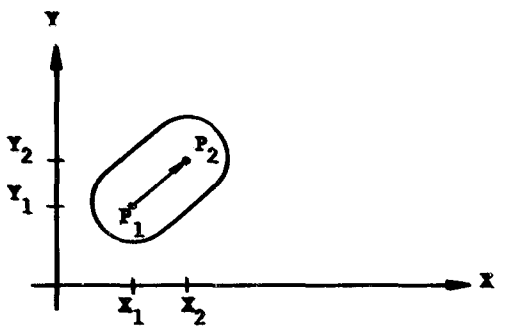
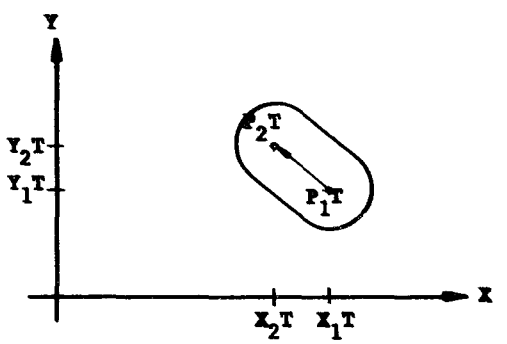


Fig. E-1 Data Flow - AUTOMAP Post Processor (Including Nesting Routine) for GE Mark Century Director

transformed part. For example, if a part were programmed with the indicated relationship to the coordinate system,



and it is desired that the part have the following relationship to the coordinate system,



the values for P_1 , P_2 , P_1T and one of the two coordinates for P_2T (either X_2T or Y_2T) must be punched in the header card.

The format of this card is:

cc 1-2 $\overline{1}\ \underline{8}$ if reflection about horizontal axis is not required
$\overline{1}\ \underline{8}$ if part is to be reflected

cc 5-10 **SCALE FACTOR**: This number is of the form XXX000, and is a multiplier. For example, 1/8 scale would be 000125. If a full-scale part is desired, 001000 must be punched in these card columns.

cc 13-18 X1 constant of form XXX000. A negative number will have a flag over the third decimal place.

cc 21-26 Y 1

cc 29-34 X 2

cc 37-42 Y 2

cc 45-50 X 1 Translated

cc 53-58 Y 1 Translated

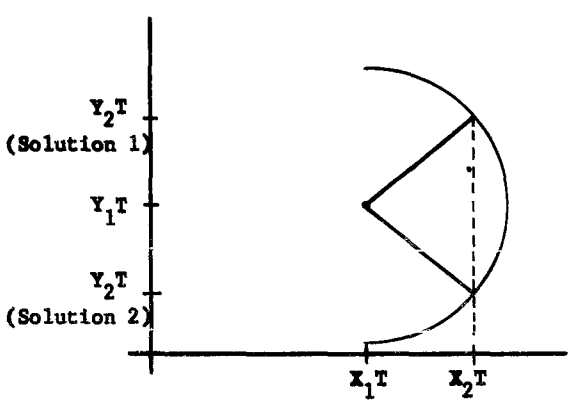
cc 61-66 X 2 Translated

cc 69-74 Y 2 Translated

cc 69 This cc is used to indicate whether X 2 or Y 2 is omitted. A flag means that Y 2 T is omitted, while the absence of a flag means that X 2 T is omitted.

cc 75-80 May be used for identification

cc 67 There are two possible solutions for X 2 T (or Y 2 T). A flag in cc 67 means to accept the more negative solution, and its absence indicates the more positive solution. For example, using a line between the key points to represent the transformed part:



There are two solutions if Y_2T is omitted. A flag in cc 67 would select the lower Y_2T in this case.

III. SPECIAL CONSIDERATIONS

1. Cards may be inserted into the data deck at any point, and a sequence error message avoided by omitting the flag in cc 72.

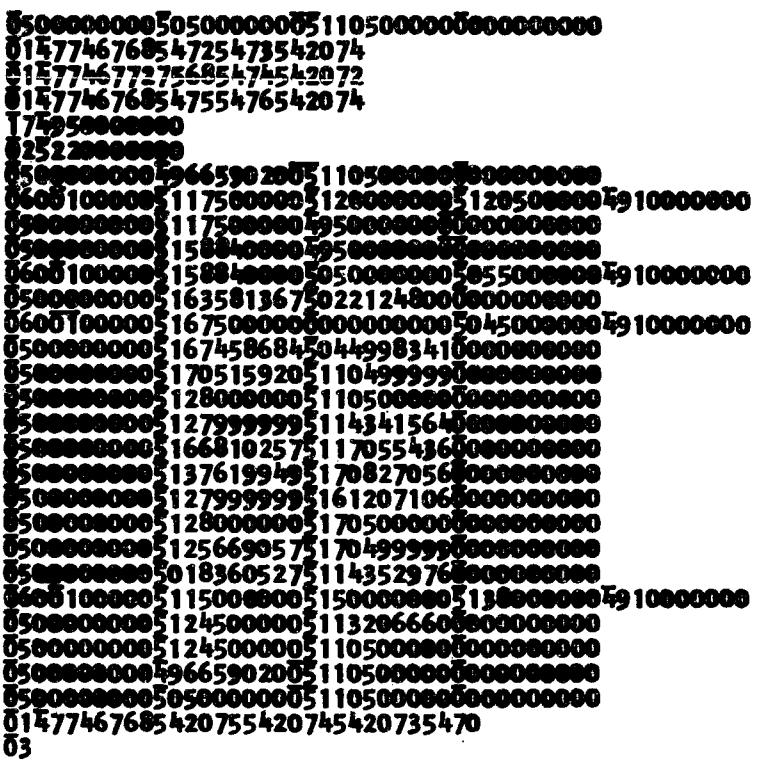
2. If a card coded rapid (with an s in cc 73) is placed in the parts program, the post processor will automatically assume a feed rate of 100"/min (rapid traverse) for the increment between the two data cards on either side of the rapid card.

3. For nesting, 100"/min feedrates are automatically generated for motions between parts.

4. If a feedrate factor greater than 5000 is calculated, the program automatically sets the feedrate factor to 5000.

SAMPLE PROBLEM FOR POST PROCESSOR

INPUT DATA

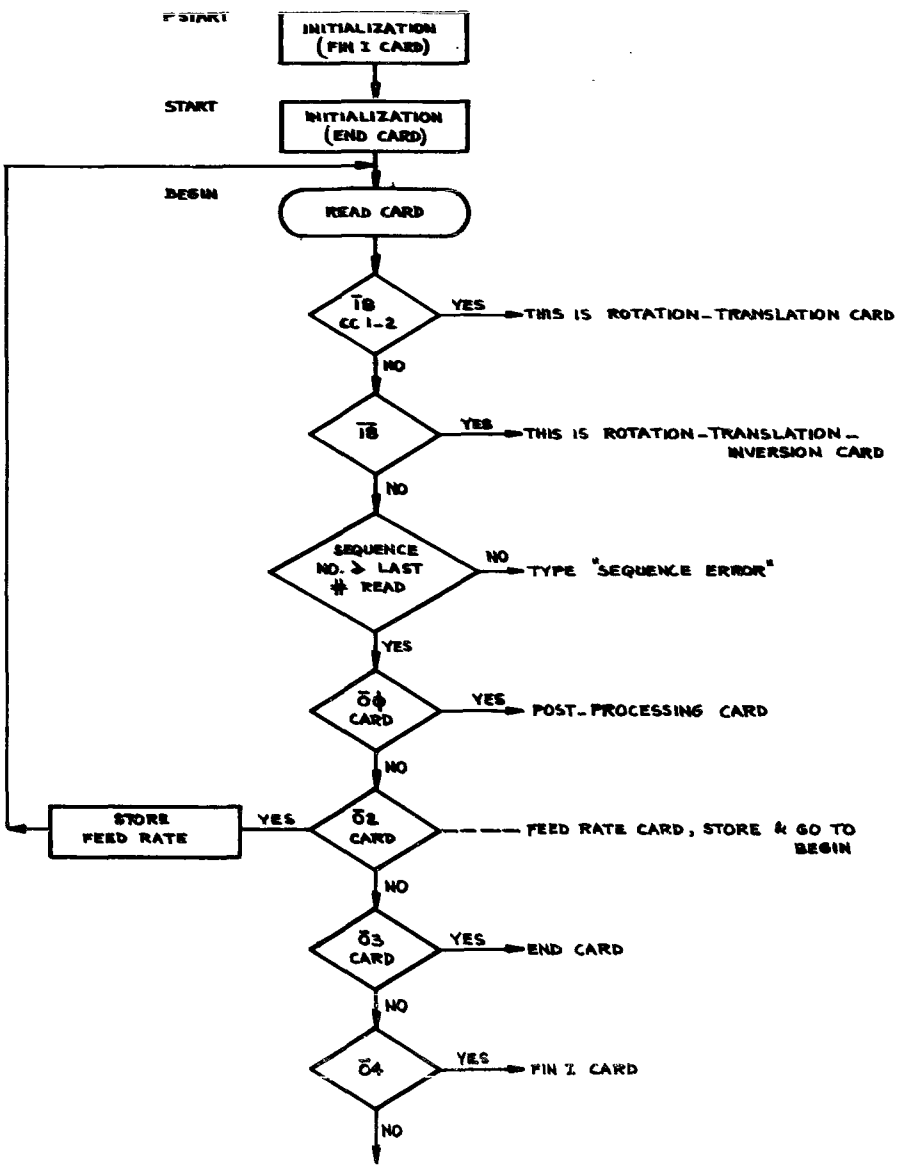


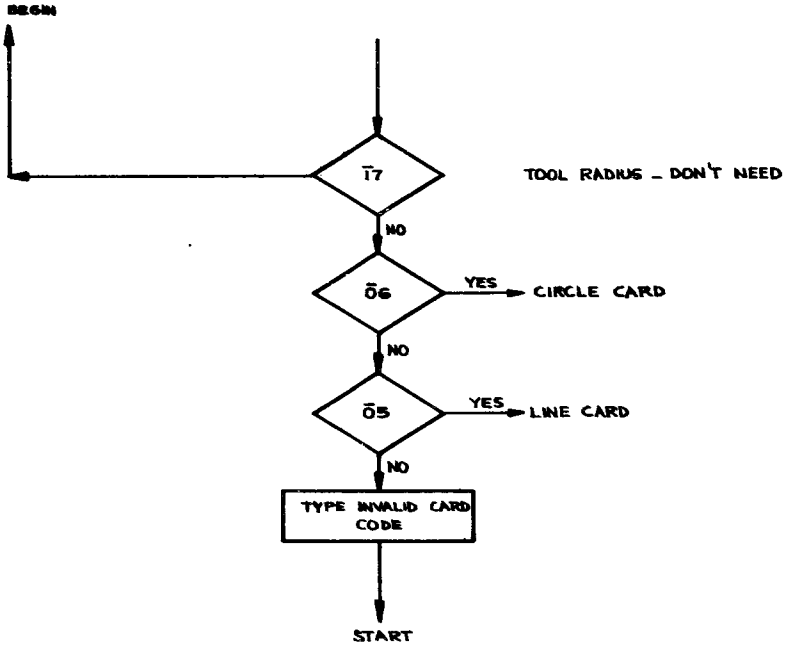
SAMPLE PROBLEM FOR POST PROCESSOR

OUTPUT DATA

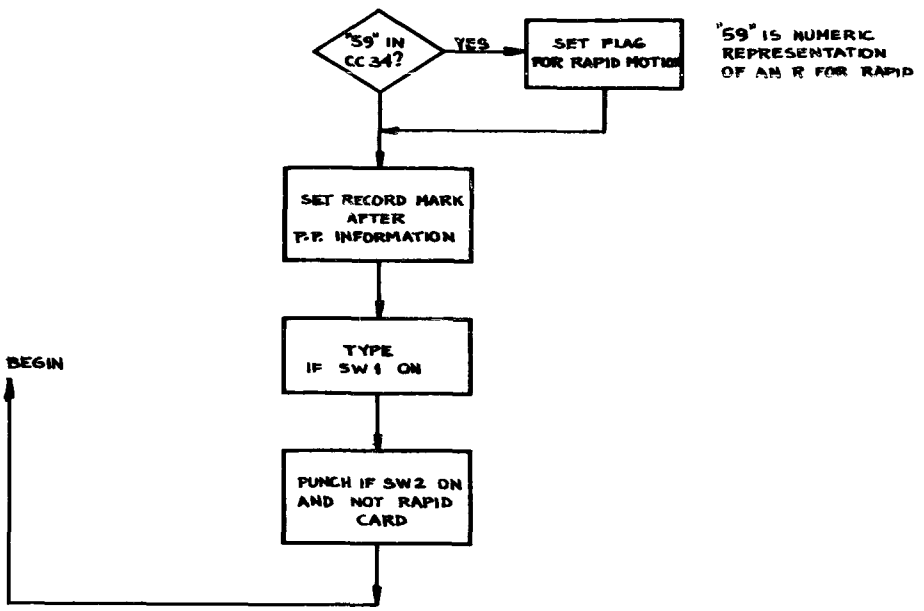
```
G4XYM2M3M-4
G4X25YM4M-2
G4XYM5M6M-4
G1X 00433Y 00000F4614
G3X 01816Y-01099J01816K00950F0975
G1X 04134Y-00000F0483
G3X 00474Y 00270J00000K00549F3636
G2X 00388Y 00229J00392K00221F4444
G1X 00306Y 00600F2969
G1X-04252Y 00000F0470
G1X 00000Y 00384F5000
G1X 03881Y 00272F0514
G1X-02919Y 05377F0326
G1X-00962Y-00962F1470
G1X 00000Y 00929F2152
G1X-00233Y 00000F5000
G1X-02383Y-05615F0327
G3X 01316Y-00235J01316K03565F0526
G3X 00950Y 00121J00000K03800F0526
G1X 00000Y-00271F5000
G1X-02516Y 00000F0794
G1X-00433Y 00000F4614
G4XYM-5M-4M-3M0
END
DELTA X SUM = 0000.000
DELTA Y SUM = 0000.000
LENGTH OF PATH =  5237303306
CUTTING TIME =  001.86
```

FLOW CHART OF POST-PROCESSOR

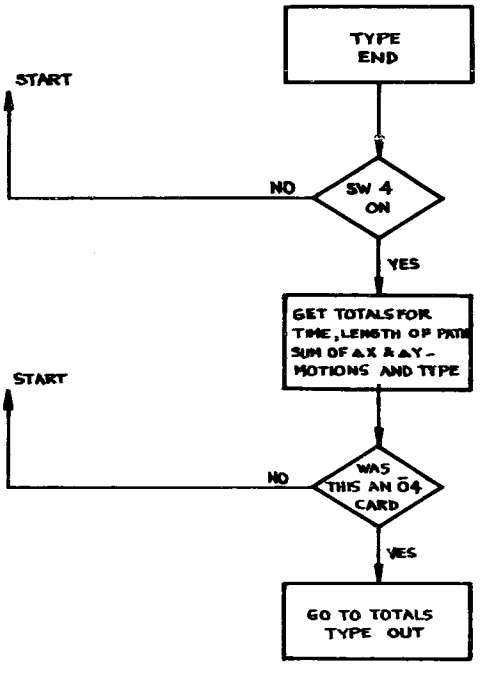



BEGIN
I7
TOOL RADIUS - DON'T NEED
NO
O6
YES
CIRCLE CARD
NO
O5
YES
LINE CARD
NO
TYPE INVALID CARD CODE
START

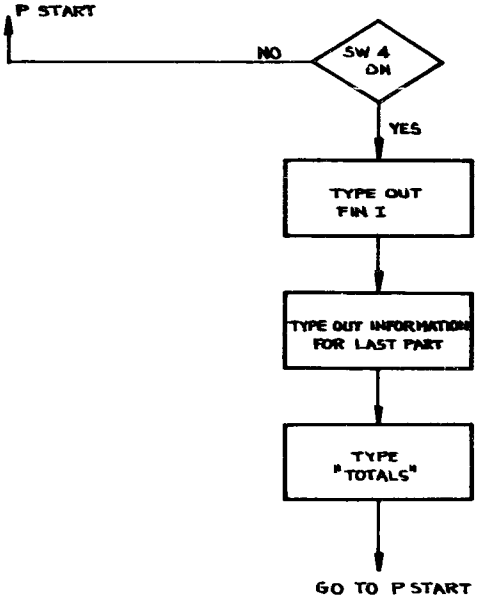
01 CARD (POST-PROCESSING INFORMATION)



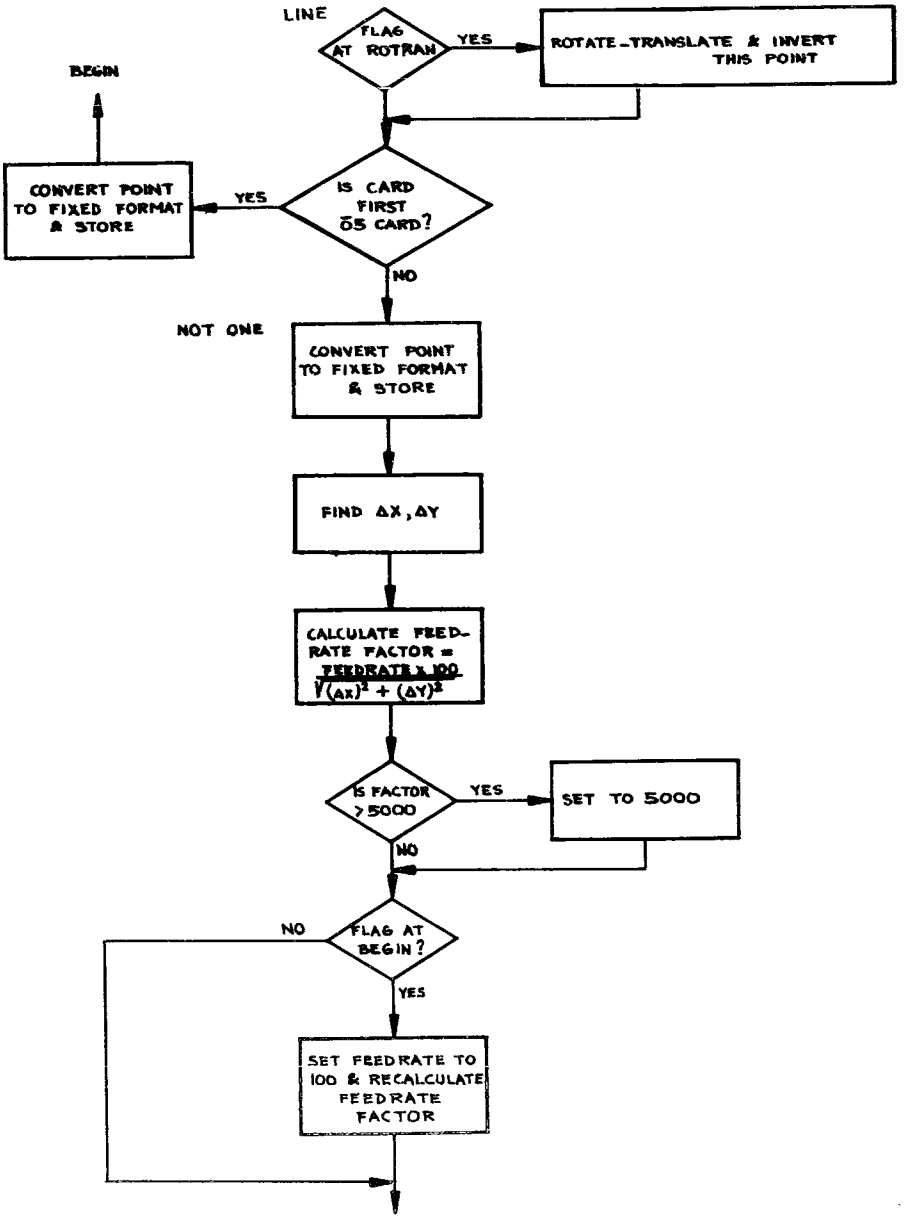
$\bar{0}3$ CARD (END OF PART)

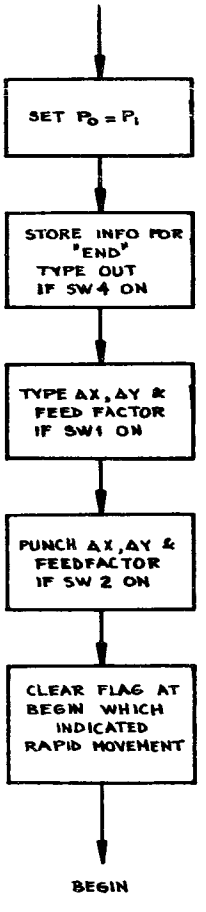


04 CARD (FIN I - END OF ALL PARTS)

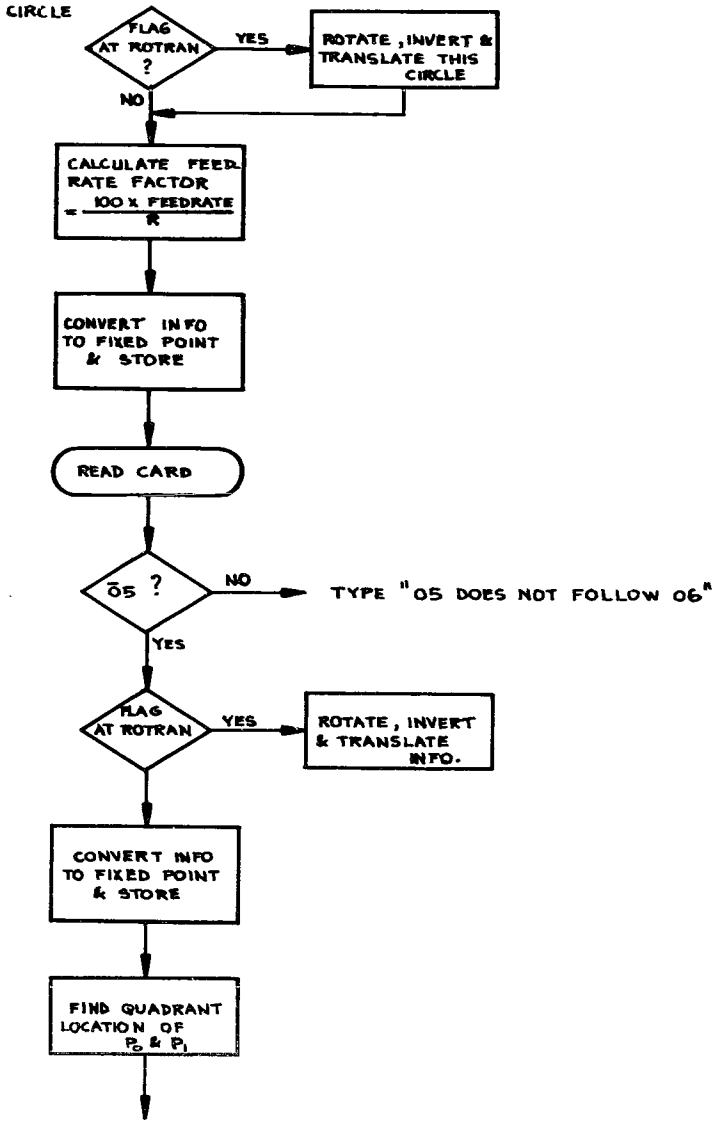


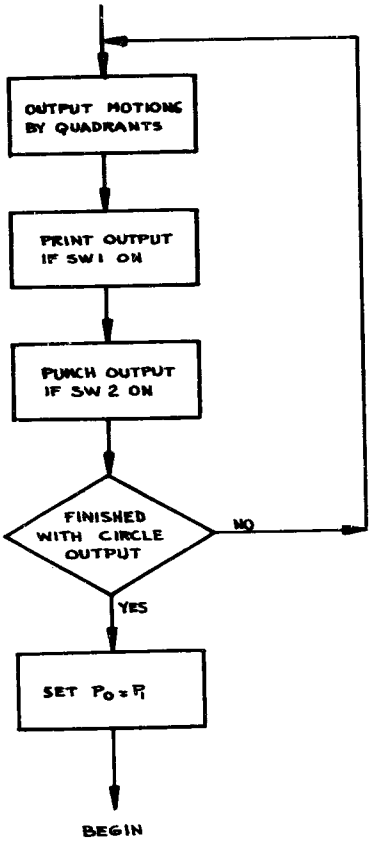
Ō5 LINE CARD


LINE
FLAG AT ROTRAN
YES
ROTATE-TRANSLATE & INVERT THIS POINT
BEGIN
CONVERT POINT TO FIXED FORMAT & STORE
YES
IS CARD FIRST Ō5 CARD?
NO
NOT ONE
CONVERT POINT TO FIXED FORMAT & STORE
FIND ΔX, ΔY
CALCULATE FEED-RATE FACTOR = FEEDRATE x 100 / √(ΔX)² + (ΔY)²
IS FACTOR > 5000
YES
SET TO 5000
NO
NO
FLAG AT BEGIN?
YES
SET FEEDRATE TO 100 & RECALCULATE FEEDRATE FACTOR

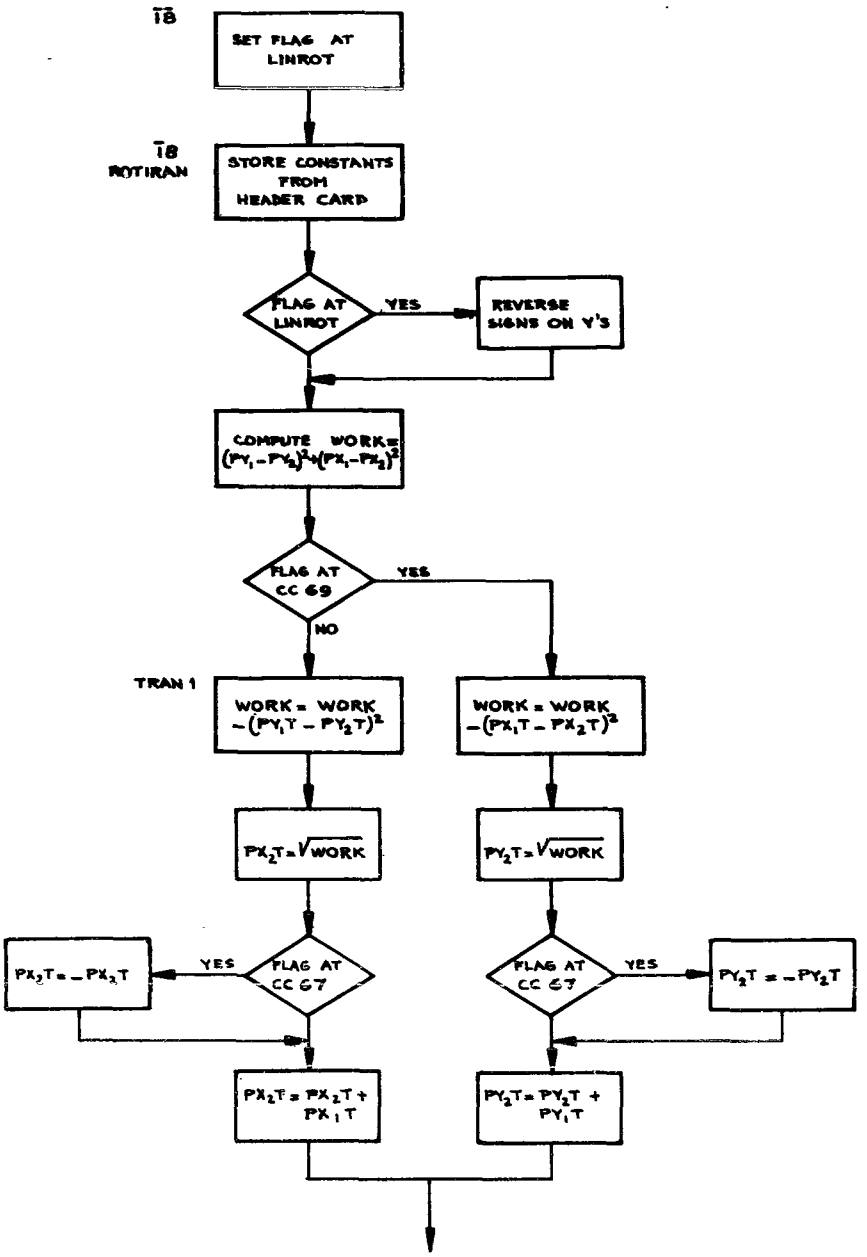

SET $P_0 = P_i$
STORE INFO FOR "END" TYPE OUT IF SW4 ON
TYPE ΔX, ΔY & FEED FACTOR IF SW1 ON
PUNCH ΔX, ΔY & FEEDFACTOR IF SW 2 ON
CLEAR FLAG AT BEGIN WHICH INDICATED RAPID MOVEMENT
BEGIN

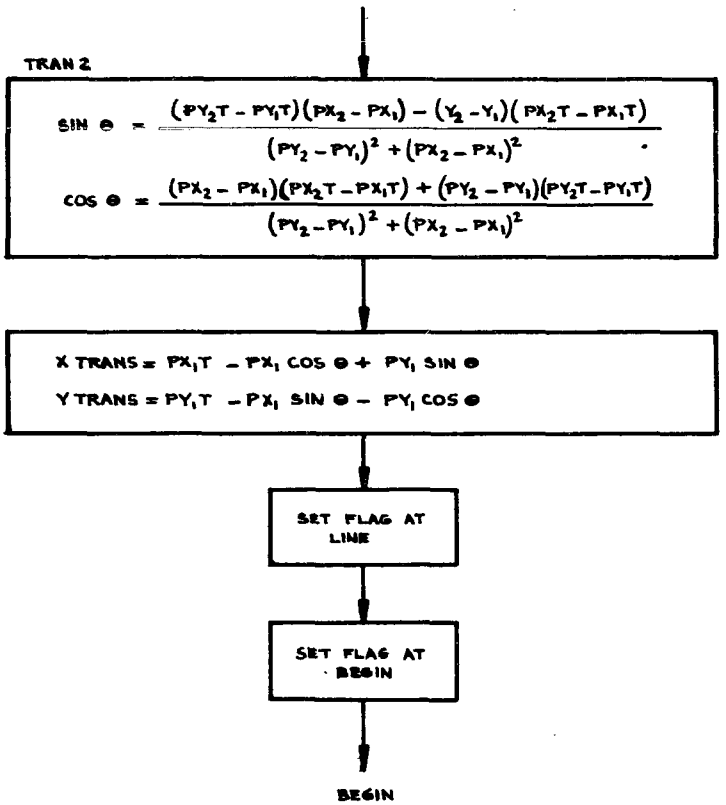
Ō6 CIRCLE CARD



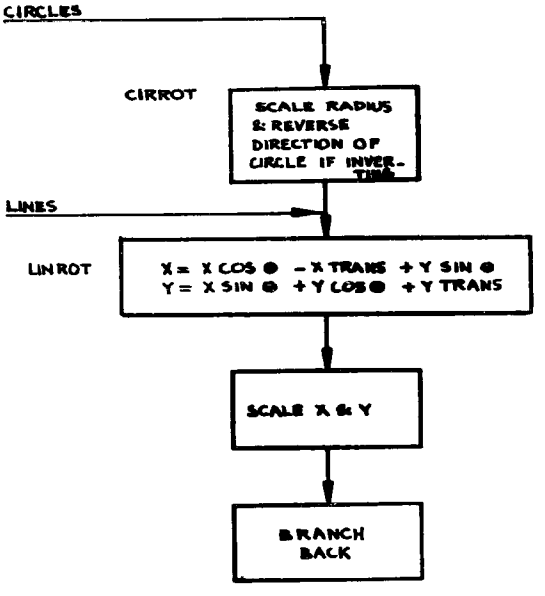

OUTPUT MOTIONS BY QUADRANTS
PRINT OUTPUT IF SW 1 ON
PUNCH OUTPUT IF SW 2 ON
FINISHED WITH CIRCLE OUTPUT
NO
YES
SET $P_0 = P_1$
BEGIN

$\bar{1}8$ OR $\bar{1}\bar{8}$ CARD (ROTATION-TRANSLATION-INVERSION HEADER CARD)




TRAN 2
SIN Θ = (PY2T - PY1T)(PX2 - PX1) - (Y2 - Y1)(PX2T - PX1T) / (PY2 - PY1)^2 + (PX2 - PX1)^2
COS Θ = (PX2 - PX1)(PX2T - PX1T) + (PY2 - PY1)(PY2T - PY1T) / (PY2 - PY1)^2 + (PX2 - PX1)^2
X TRANS = PX1T - PX1 COS Θ + PY1 SIN Θ
Y TRANS = PY1T - PX1 SIN Θ - PY1 COS Θ
SET FLAG AT LINE
SET FLAG AT BEGIN
BEGIN

ROTATION - TRANSLATION - INVERSION SUB-ROUTINE



```
I-ADD OP              P/I LABEL   OP       OPERANDS

360007200500360020100500440001200275260005900274250001100000260009000269
260009500264310000000200260011400274250000000011490001200900
02178 26 15094 14115 00010 PSTART TF     FTIME,FLTO*
02190 26 15083 14115 00020         TF     FLENGT,FLTO*
02202 26 14991 14196 00030         TF     SUMDXF,NIL7*
02214 26 15001 14196 00040         TF     SUMDYF,NIL7*
02226 26 15099 14115 00050         TF     FCHECK,FLTO*
02238 47 02286 00300 00060         BNC3   *&46*
02250 39 14591 00200 00070         WAPT   ONES*
02262 37 13877 00100 00080         RATY   AREA,,,ENTER HEADING IF SENSE SWITCH 3 ON.*
02274 39 13877 00200 00090         WAPT   AREA*
02286 26 14105 14115 00100         TF     FCRATE,FLTO,,HOUSE KEEPING ROUTINE*
02298 26 14125 14115 00110         TF     XO,FLTO*
02310 26 14135 14115 00120         TF     YO,FLTO*
02322 26 14145 14115 00130         TF     X1,FLTO*
02334 26 14155 14115 00140         TF     Y1,FLTO*
02346 26 14165 14175 00150         TF     FEED,NIL*
02358 26 14182 14196 00160         TF     XOFXRD,NIL7*
02370 26 14189 14196 00170         TF     YOFXRD,NIL7*
02382 26 14203 14196 00180         TF     DELTAX,NIL7*
02394 26 14210 14196 00190         TF     DELTAY,NIL7*
02406 26 14217 14196 00200         TF     TEMPX,NIL7*
02418 26 14224 14196 00210         TF     TEMPY,NIL7*
02430 26 14231 14196 00220         TF     OFSETX,NIL7*
02442 26 14238 14196 00230         TF     OFSETY,NIL7*
02454 16 14240 000-0 00240         TFM    DIREC,0,10*
02466 26 14770 14115 00250         TF     TIME,FLTO*
02478 26 14759 14115 00260         TF     LENGTH,FLTO*
02490 26 14783 14196 00270         TF     SUMDX,NIL7*
02502 26 14793 14196 00280         TF     SUMDY,NIL7*
02514 16 13795 0-000 00290 START   TFM    CNTR,0,8*
02526 33 17460 00000 00300         CF     LINROT*
02538 33 15120 00000 00310         CF     RCTRAN*
02550 33 08778 00000 00320         CF     LINE*
02562 36 13796 00500 00330 BEGIN   RNCD   A*
02574 14 13797 000J8 00340         CM     A&1,18,10,ROTRATION-TRANSLATION-INVERSION CARD*
02586 46 15120 01200 00350         BE     RCTRAN*
02598 14 13797 000J6 00360         CM     A&1,-18,10*
```

```
I-ADD OP              P/L LABEL   OP       OPERANDS

02610 46 15108 01200 00370        BE     RCTRAN-12*
02622 44 02670 13872 00380        BNF    *&48,A&76,,CHECK TO SEE IF COMMENT CARR*
02634 24 13875 13795 00390        C      A&79,CNTR,,SEQUENCE CHECK*
02646 47 04202 01300 00400        BN     SEQERR*
02658 26 13795 13875 00410        TF     CNTR,A&79*
02670 14 13797 000-1 00420        CM     A&1,01,10,POST PROCESSING INFORMATION*
02682 47 02894 01200 00430        BNE    BEG1*
02694 14 13799 000N9 00440        CM     A&3,59,10*
02706 47 02730 01200 00450        BNE    *&24*
02718 32 02562 00000 00460        SF     BEGIN*
02730 16 02765 J3797 00470        TFM    *&35,A&1*
02742 11 02765 000-1 00480        AM     *&23,1,10*
02754 45 02742 00000 00490        BNR    *-12,0*
02766 25 0276N 14351 00500        TD     *-1,ERR5&4 ,6*
02778 11 02765 000-1 00510        AM     *-13,1,10*
02790 25 0276N 13716 00520        TD     *-25,RM,6*
02802 47 02838 00100 00530        BNC1   *&36*
02814 34 00000 00102 00540        RCTY    *
02826 39 13799 00100 00550        WATY   A&3*
02838 47 02562 00200 00560        BNC2   BEGIN*
02850 44 02874 02562 00570        BNF    *&24,BEGIN*
02862 49 02562 00000 00580        B      BEGIN*
02874 39 13799 00200 00590        WAPT   A&3*
02886 49 02562 00000 00600        B      BEGIN*
02894                00610        DORG   *-3*
02894 14 13797 000-2 00620 BEG1   CM     A&1,02,10,FEEDRATE CARD*
02906 47 02942 01200 00630        BNE    *&36*
02918 26 14105 13807 00640        TF     FCRATE,A&11*
02930 49 02562 00000 00650        B      BEGIN*
02942 14 13797 000-3 00660        CM     A&1,03,10,END CARD*
02954 47 03646 01200 00670        BNE    CODE4*
02966 34 00000 00102 00680        RCTY    *
02978 39 14243 00100 00690        WATY   END*
02990 47 02514 00400 00700        BNC4   START*
03002 34 00000 00102 00710 JUMP   RCTY    *
03014 21 14991 14783 00720        A      SUMDXF,SUMDX*
03026 21 15001 14793 00730        A      SUMDYF,SUMDY*
03038 16 00469 -3073 00740        FD     FCHECK,FRAPID*
```

```
 I-ADD OP                P/L LABEL   OP       OPERANDS

03050 26 01260 18099
03062 49 01422 J8109
03074 26 14770 00099 00750          TF      TIME,99*
03086 16 00469 -3121 00760          FD      LENGTH,FDRATE*
03098 26 01260 14759
03110 49 01422 J4105
03122 16 00469 -3157 00770          FA      TIME,99*
03134 16 00445 J4770
03146 49 00422 -0099
03158 16 00469 -3193 00780          FA      FTIME,TIME*
03170 16 00445 J5094
03182 49 00422 J4770
03194 16 00469 -3229 00790          FA      LENGTH,FCHECK*
03206 16 00445 J4759
03218 49 00422 J8099
03230 16 00469 -3265 00800          FA      FLENGT,LENGTH*
03242 16 00445 J5083
03254 49 00422 J4759
03266 73 14925 14780 00810          TNF     SX1,SUMDX-3*
03278 32 14781 00000 00820          SF      SUMDX-2*
03290 73 14933 14783 00830          TNF     SX2,SUMDX*
03302 39 14891 00100 00840          WATY    SUMX*
03314 34 00000 00102 00850          RCTY     *
03326 73 14971 14790 00860          TNF     SY1,SUMDY-3*
03338 32 14791 00000 00870          SF      SUMDY-2*
03350 73 14979 14793 00880          TNF     SY2,SUMDY*
03362 39 14937 00100 00890          WATY    SUMY*
03374 34 00000 00102 00900          RCTY     *
03386 39 15003 00100 00910          WATY    MES1*
03398 38 14750 00100 00920          WNTY    LENGTH-9*
03410 34 00000 00102 00930          RCTY     *
03422 39 15041 00100 00940          WATY    MES2*
03434 26 13753 14770 00950          TF      FLTING,TIME*
03446 17 13526 000-0 00960          BTM     FLTOFX,0,10*
03458 32 13754 00000 00970          SF      FIXED-14*
03470 26 14770 13760 00980          TF      TIME,FIXED-8*
03482 73 14657 14766 00990          TNF     TOUT1,TIME-4*
03494 32 14767 00000 01000          SF      TIME-3*
```

```
I-ADD OP              P/L LABEL   OP       OPERANDS

03506 73 14663 14768 01010        TNF    TOUT2,TIME-2*
03518 39 14653 00100 01020        WATY   TIMEOT*
03530 26 14770 14115 01030        TF     TIME,FLTO*
03542 26 18099 14115 01040        TF     FCHECK,FLTO*
03554 26 14759 14115 01050        TF     LENGTH,FLTO*
03566 26 14783 14196 01060        TF     SUMDX,NIL7*
03578 26 14793 14196 01070        TF     SUMDY,NIL7*
03590 34 00000 00102 01080        RCTY    *
03602 34 00000 00102 01090        RCTY    *
03614 14 13797 000-4 01100        CM     A&1,4,10*
03626 46 03718 01200 01110        BE     CODE4&72*
03638 49 02514 00000 01120        B      START*
03646                01130        DORG   *-3*
03646 14 13797 000-4 01140 CODE4  CM     A&1,4,10,FINI CARD*
03658 47 04074 01200 01150        BNE    CODE17*
03670 34 00000 00102 01160        RCTY    *
03682 39 14251 00100 01170        WATY   FINI*
03694 47 02178 00400 01180        BNC4   PSTART*
03706 49 03002 00000 01190        B      JUMP*
03718 34 00000 00102 01200        RCTY    *
03730 39 14667 00100 01210        WATY   TOTALS*
03742 34 00000 00102 01220        RCTY    *
03754 73 14925 14988 01230        TNF    SX1,SUMDXF-3*
03766 32 14989 00000 01240        SF     SUMDXF-2*
03778 73 14933 14991 01250        TNF    SX2,SUMDXF*
03790 39 14891 00100 01260        WATY   SUMX*
03802 34 00000 00102 01270        RCTY    *
03814 73 14971 14998 01280        TNF    SY1,SUMDYF-3*
03826 32 14999 00000 01290        SF     SUMDYF-2*
03838 73 14979 15001 01300        TNF    SY2,SUMDYF*
03850 39 14937 00100 01310        WATY   SUMY*
03862 34 00000 00102 01320        RCTY    *
03874 39 15003 00100 01330        WATY   MES1*
03886 38 15074 00100 01340        WNTY   FLENGT-9*
03898 34 00000 00102 01350        RCTY    *
03910 39 15041 00100 01360        WATY   MES2*
03922 26 13753 15094 01370        TF     FLTING,FTIME*
03934 17 13526 000-0 01380        BTM    FLTOFX,0,10*
```

```
I-ADD OP              P/L LABEL   OP      OPERANDS

03946 32 13754 00000 01390        SF     FIXED-14*
03958 26 14770 13760 01400        TF     TIME,FIXED-8*
03970 73 14657 14766 01410        TNF    TOUT1,TIME-4*
03982 32 14767 00000 01420        SF     TIME-3*
03994 73 14663 14768 01430        TNF    TOUT2,TIME-2*
04006 39 14653 00100 01440        WATY   TIMEOT*
04018 26 15094 14115 01450        TF     FTIME,FLTO*
04030 26 15083 14115 01460        TF     FLENGT,FLTO*
04042 26 14991 14196 01470        TF     SUMDXF,NIL7*
04054 26 15001 14196 01480        TF     SUMDYF,NIL7*
04066 49 02178 00000 01490        B      PSTART*
04074                01500        DORG   *-3*
04074 14 13797 000J7 01510 CODE17 CM     A&1,17,10*
04086 47 04110 01200 01520        BNE    *&24*
04098 49 02562 00000 01530        B      BEGIN*
04110 14 13797 000-6 01540        CM     A&1,06,10,CIRCULAR INFORMATION*
04122 46 04234 01200 01550        BE     CIRCLE*
04134 14 13797 000-5 01560        CM     A&1,05,10,LINE INFORMATION*
04146 46 08778 01200 01570        BE     LINE*
04158 34 00000 00102 01580        RCTY    *
04170 39 14261 00100 01590        WATY   ERR4,,,INVALID CARD CODE*
04182 48 00000 00000 01600        H       *
04194 49 02514 00000 01610        B      START*
04202                01620        DORG   *-3*
04202 34 00000 00102 01630 SEQERR RCTY    *
04214 39 14297 00100 01640        WATY   ERR3,,,SEQUENCE ERROR TYPE OUT*
04226 49 02514 00000 01650        B      START*
04234                01660        DORG   *-3*
04234 44 04258 15120 01670 CIRCLE BNF    *&24,ROTRAN*
04246 17 17352 000R9 01680        BTM    CIRROT,99,10*
04258 26 14165 14105 01690        TF     FEED,FDRATE*
04270 16 00469 -4305 01700        FD     FEED,A&39*
04282 26 01260 14165
04294 49 01422 J3835
04306 26 14165 00099 01710        TF     FEED,99*
04318 24 14165 14335 01720        C      FEED,FE5*
04330 47 04366 01300 01730        BN     *&36*
04342 16 14165 0N000 01740        TFM    FEED,5000,8,SET FEED RATE # TO 5000*
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I-ADD OP                P/L LABEL   OP       OPERANDS

04354 49 04426 00000 01750        B       *&72*
04366 26 13753 14165 01760        TF      FLTING,FEED*
04378 17 13526 000-0 01770        BTM     FLTOFX,0,10*
04390 32 13754 00000 01780        SF      FIXED-14*
04402 26 14345 13760 01790        TF      WORK,FIXED-8*
04414 26 14165 14343 01800        TF      FEED,WORK-2,, MULT BY 100*
04426 24 13815 14175 01810        C       A&19,NIL*
04438 47 04462 01200 01820        BNE     *&24*
04450 26 13815 14115 01830        TF      A&19,FLTO*
04462 24 13825 14175 01840        C       A&29,NIL*
04474 47 04498 01200 01850        BNE     *&24*
04486 26 13825 14115 01860        TF      A&29,FLTO*
04498 26 13753 13815 01870        TF      FLTING,A&19*
04510 17 13526 000-0 01880        BTM     FLTOFX,0,10*
04522 32 13754 00000 01890        SF      FIXED-14*
04534 26 14345 13760 01900        TF      WORK,FIXED-8*
04546 11 14345 000-5 01910        AM      WORK,5,10*
04558 71 14344 14345 01920        MF      WORK-1,WORK*
04570 26 14521 14344 01930        TF      UC,WORK-1*
04582 26 13753 13825 01940        TF      FLTING,A&29*
04594 17 13526 000-0 01950        BTM     FLTOFX,0,10*
04606 32 13754 00000 01960        SF      FIXED-14*
04618 26 14345 13760 01970        TF      WORK,FIXED-8*
04630 11 14345 000-5 01980        AM      WORK,5,10*
04642 71 14344 14345 01990        MF      WORK-1,WORK*
04654 26 14531 14344 02000        TF      VC,WORK-1*
04666 26 14240 13800 02010        TF      DIREC,A&4*
04678 26 13753 13835 02020        TF      FLTING,A&39*
04690 17 13526 000-0 02030        BTM     FLTOFX,0,10*
04702 32 13754 00000 02040        SF      FIXED-14*
04714 26 14345 13760 02050        TF      WORK,FIXED-8*
04726 11 14345 000-5 02060        AM      WORK,5,10*
04738 71 14344 14345 02070        MF      WORK-1,WORK*
04750 26 14565 14344 02080        TF      R,WORK-1*
04762 26 14729 13835 02090        TF      FR,A&39*
04774 36 13796 00500 02100        RNCD    A,,,            READ 05 CARD WHICH FOLLOWS 06 CARD*
04786 24 13875 13795 02110        C       A&79,CNTR*
04798 47 04202 01300 02120        BN      SEQERR*
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   I-ADD OP              P/L LABEL   OP       OPERANDS

04810 26 13795 13875 02130         TF     CNTR,A&79*
04822 14 13797 000-5 02140         CM     A&1,5,10*
04834 46 04894 01200 02150         BE     *&60*
04846 34 00000 00102 02160         RCTY    *
04858 39 14347 00100 02170         WATY   ERR5,,,        05 DOES NOT FOLLOW 06*
04870 48 00000 00000 02180         H       *
04882 49 02514 00000 02190         B      START*
04894 44 04918 15120 02200         BNF    *&24,ROTRAN*
04906 17 17460 000R9 02210         BTM    LINROT,99,10*
04918 24 13815 14175 02220         C      A&19,NIL*
04930 47 04954 01200 02230         BNE    *&24*
04942 26 13815 14115 02240         TF     A&19,FLTO*
04954 24 13825 14175 02250         C      A&29,NIL*
04966 47 04990 01200 02260         BNE    *&24*
04978 26 13825 14115 02270         TF     A&29,FLTO*
04990 26 13753 13815 02280         TF     FLTING,A&19*
05002 17 13526 000-0 02290         BTM    FLTOFX,0,10*
05014 32 13754 00000 02300         SF     FIXED-14*
05026 26 14345 13760 02310         TF     WORK,FIXED-8*
05038 11 14345 000-5 02320         AM     WORK,5,10*
05050 71 14344 14345 02330         MF     WORK-1,WORK*
05062 26 14583 14344 02340         TF     U1,WORK-1*
05074 26 13753 13825 02350         TF     FLTING,A&29*
05086 17 13526 000-0 02360         BTM    FLTOFX,0,10*
05098 32 13754 00000 02370         SF     FIXED-14*
05110 26 14345 13760 02380         TF     WORK,FIXED-8*
05122 11 14345 000-5 02390         AM     WORK,5,10*
05134 71 14344 14345 02400         MF     WORK-1,WORK*
05146 26 14589 14344 02410         TF     V1,WORK-1*
05158 26 14217 14583 02420         TF     TEMPX,U1*
05170 26 14224 14589 02430         TF     TEMPY,V1*
05182 26 14571 14182 02440         TF     U0,XOFXRD*
05194 26 14577 14189 02450         TF     V0,YOFXRD*
05206 26 14541 14571 02460         TF     ARGX,U0*
05218 22 14541 14521 02470         S      ARGX,UC*
05230 26 14547 14577 02480         TF     ARGY,V0*
05242 22 14547 14531 02490         S      ARGY,VC*
05254 32 15106 00000 02500         SF     POIND*
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I-ADD OP              P/L LABEL   OP      OPERANDS

05266 17 10492 000-0 02510        BTM   FINDQD,0,10*
05278 26 14533 14549 02520        TF    POQUAD,QUAD*
05290 26 14541 14583 02530        TF    ARGX,U1*
05302 22 14541 14521 02540        S     ARGX,UC*
05314 26 14547 14589 02550        TF    ARGY,V1*
05326 22 14547 14531 02560        S     ARGY,VC*
05338 33 15106 00000 02570        CF    POIND*
05350 17 10492 000-0 02580        BTM   FINDQD,0,10*
05362 26 14535 14549 02590        TF    P1QUAD,QUAD*
05374 24 14535 14533 02600        C     P1QUAD,POQUAD*
05386 46 07846 01200 02610        BE    SAMEQD*
05398 14 14533 000-1 02620        CM    POQUAD,1,10,  POINTS LIE IN DIFFERENT QUADRANTS*
05410 46 07726 01200 02630        BE    POQD1*
05422 14 14533 000-2 02640        CM    POQUAD,2,10*
05434 46 07606 01200 02650        BE    POQD2*
05446 14 14533 000-3 02660        CM    POQUAD,3,10*
05458 46 07486 01200 02670        BE    POQD3*
05470 14 14535 000-3 02680 POQD4  CM    P1QUAD,3,10,  POIN QUADRANT 4*
05482 46 07462 01200 02690        BE    P01Q43*
05494 14 14535 000-2 02700        CM    P1QUAD,02,10*
05506 46 07438 01200 02710        BE    P01Q42*
05518 44 05986 14240 02720 P01Q41 BNF   CCW41,DIREC*
05530 26 14583 14521 02730 CW41   TF    U1,UC,,       MOTION IS CW 4TO1*
05542 26 14589 14531 02740        TF    V1,VC*
05554 22 14589 14565 02750        S     V1,R*
05566 17 11050 000-0 02760        BTM   OUTPUT,0,10*
05578 26 14571 14583 02770        TF    U0,U1*
05590 26 14577 14589 02780        TF    V0,V1*
05602 26 14583 14521 02790 CW31   TF    U1,UC,,       MOTION IS CW 3TO1*
05614 22 14583 14565 02800        S     U1,R*
05626 26 14589 14531 02810        TF    V1,VC*
05638 17 11050 000-0 02820        BTM   OUTPUT,0,10*
05650 26 14571 14583 02830        TF    U0,U1*
05662 26 14577 14589 02840        TF    V0,V1*
05674 26 14583 14521 02850 CW21   TF    U1,UC,,       MOTION IS CW 2TO 1*
05686 26 14589 14531 02860        TF    V1,VC*
05698 21 14589 14565 02870        A     V1,R*
05710 17 11050 000-0 02880        BTM   OUTPUT,0,10*
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  I-ADD OP              P/L LABEL   OP      OPERANDS
05722 26 14571 14583 02890        TF     U0,U1*
05734 26 14577 14589 02900        TF     V0,V1*
05746 26 14583 14217 02910 CW11SH TF     U1,TEMPX,,     MOTION IS CW 1 TO 1 SHORT WAY.. OR FINAL MOTI
05758 26 14589 14224 02920        TF     V1,TEMPY*
05770 17 11050 000-0 02930        BTM    OUTPUT,0,10*
05782 26 14182 14217 02940        TF     X0FXRD,TEMPX*
05794 26 14189 14224 02950        TF     Y0FXRD,TEMPY*
05806 26 14125 13815 02960        TF     X0,A&19*
05818 26 14135 13825 02970        TF     Y0,A&29*
05830 49 02562 00000 02980        B      BEGIN*
05842 26 14583 14521 02990 CCW21  TF     U1,UC,,        MOTION IS CCW 2 TO 1*
05854 22 14583 14565 03000        S      U1,R*
05866 26 14589 14531 03010        TF     V1,VC*
05878 17 11050 000-0 03020        BTM    OUTPUT,0,10*
05890 26 14571 14583 03030        TF     U0,U1*
05902 26 14577 14589 03040        TF     V0,V1*
05914 26 14583 14521 03050 CCW31  TF     U1,UC,,        MOTION IS CCW 3 TO 1*
05926 26 14589 14531 03060        TF     V1,VC*
05938 22 14589 14565 03070        S      V1,R*
05950 17 11050 000-0 03080        BTM    OUTPUT,0,10*
05962 26 14571 14583 03090        TF     U0,U1*
05974 26 14577 14589 03100        TF     V0,V1*
05986 26 14583 14521 03110 CCW41  TF     U1,UC,,        MOTION IS CCW FROM 4 TO 1*
05998 21 14583 14565 03120        A      U1,R*
06010 26 14589 14531 03130        TF     V1,VC*
06022 17 11050 000-0 03140        BTM    OUTPUT,0,10*
06034 26 14571 14583 03150        TF     U0,U1*
06046 26 14577 14589 03160        TF     V0,V1*
06058 49 05746 00000 03170        B      CW11SH,,,      OUTPTU LAST POINT IN 1*
06070 26 14583 14521 03180 CW12   TF     U1,UC,,        CW 1TO 2*
06082 21 14583 14565 03190        A      U1,R*
06094 26 14589 14531 03200        TF     V1,VC*
06106 17 11050 000-0 03210        BTM    OUTPUT,0,10*
06118 26 14571 14583 03220        TF     U0,U1*
06130 26 14577 14589 03230        TF     V0,V1*
06142 26 14583 14521 03240 CW42   TF     U1,UC*
06154 26 14589 14531 03250        TF     V1,VC*
06166 22 14589 14565 03260        S      V1,R*
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I-ADD OP              P/L LABEL   OP       OPERANDS

06178 17 11050 000-0 03270        BTM    OUTPUT,0,10*
06190 26 14571 14583 03280        TF     UO,U1*
06202 26 14577 14589 03290        TF     VO,V1*
06214 26 14585 14521 03300 CW32   TF     U1,UC,,        CW 3 TO 2*
06226 22 14585 14565 03310        S      U1,R*
06238 26 14589 14531 03320        TF     V1,VC*
06250 17 11050 000-0 03330        BTM    OUTPUT,0,10*
06262 26 14571 14583 03340        TF     UO,U1*
06274 26 14577 14589 03350        TF     VO,V1*
06286 49 05746 00000 03360        B      CW11SH,,,      OUTPUT LAST POINT*
06298 26 14583 14521 03370 CCW32  TF     U1,UC,,        CCW 3 TO 2*
06310 26 14589 14531 03380        TF     V1,VC*
06322 22 14589 14565 03390        S      V1,R*
06334 17 11050 000-0 03400        BTM    OUTPUT,0,10*
06346 26 14571 14583 03410        TF     UO,U1*
06358 26 14577 14589 03420        TF     VO,V1*
06370 26 14585 14521 03430 CCW42  TF     U1,UC*
06382 21 14585 14565 03440        A      U1,R*
06394 26 14589 14531 03450        TF     V1,VC*
06406 17 11050 000-0 03460        BTM    OUTPUT,0,10*
06418 26 14571 14583 03470        TF     UO,U1*
06430 26 14577 14589 03480        TF     VO,V1*
06442 26 14583 14521 03490 CCW12  TF     U1,UC*
06454 26 14589 14531 03500        TF     V1,VC*
06466 21 14589 14565 03510        A      V1,R*
06478 17 11050 000-0 03520        BTM    OUTPUT,0,10*
06490 26 14571 14583 03530        TF     UO,U1*
06502 26 14577 14589 03540        TF     VO,V1*
06514 49 05746 00000 03550        B      CW11SH,,,      OUTPUT LAST POINT*
06526 26 14583 14521 03560 CW23   TF     U1,UC,,        CW 2 TO 3*
06538 26 14589 14531 03570        TF     V1,VC*
06550 21 14589 14565 03580        A      V1,R*
06562 17 11050 000-0 03590        BTM    OUTPUT,0,10*
06574 26 14571 14583 03600        TF     UO,U1*
06586 26 14577 14589 03610        TF     VO,V1*
06598 26 14583 14521 03620 CW13   TF     U1,UC*
06610 21 14583 14565 03630        A      U1,R*
06622 26 14589 14531 03640        TF     V1,VC*
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 I-ADD OP              P/L LABEL   OP      OPERANDS

 06634 17 11050 000-0 03650        BTM   OUTPUT,0,10*
 06646 26 14571 14583 03660        TF    U0,U1*
 06658 26 14577 14589 03670        TF    V0,V1*
 06670 26 14583 14521 03680 CW43   TF    U1,UC*
 06682 26 14589 14531 03690        TF    V1,VC*
 06694 22 14589 14565 03700        S     V1,R*
 06706 17 11050 000-0 03710        BTM   OUTPUT,0,10*
 06718 26 14571 14583 03720        TF    U0,U1*
 06730 26 14577 14589 03730        TF    V0,V1*
 06742 49 05746 00000 03740        B     CW11SH,,,     OUTPUT LAST POINT IN 3 CW*
 06754 26 14583 14521 03750 CCW43  TF    U1,UC,,       CCW 4 TO 3*
 06766 21 14583 14565 03760        A     U1,R*
 06778 26 14589 14531 03770        TF    V1,VC*
 06790 17 11050 000-0 03780        BTM   OUTPUT,0,10*
 06802 26 14571 14583 03790        TF    U0,U1*
 06814 26 14577 14589 03800        TF    V0,V1*
 06826 26 14583 14521 03810 CCW13  TF    U1,UC*
 06838 26 14589 14531 03820        TF    V1,VC*
 06850 21 14589 14565 03830        A     V1,R*
 06862 17 11050 000-0 03840        BTM   OUTPUT,0,10*
 06874 26 14571 14583 03850        TF    U0,U1*
 06886 26 14577 14589 03860        TF    V0,V1*
 06898 26 14583 14521 03870 CCW23  TF    U1,UC*
 06910 22 14583 14565 03880        S     U1,R*
 06922 26 14589 14531 03890        TF    V1,VC*
 06934 17 11050 000-0 03900        BTM   OUTPUT,0,10*
 06946 26 14571 14583 03910        TF    U0,U1*
 06958 26 14577 14589 03920        TF    V0,V1*
 06970 49 05746 00000 03930        B     CW11SH,,,     OUTPUT LAST POINT IN 3 CCW*
 06982 26 14583 14521 03940 CW34   TF    U1,UC,,       CW 3 TO 4*
 06994 22 14583 14565 03950        S     U1,R*
 07006 26 14589 14531 03960        TF    V1,VC*
 07018 17 11050 000-0 03970        BTM   OUTPUT,0,10*
 07030 26 14571 14583 03980        TF    U0,U1*
 07042 26 14577 14589 03990        TF    V0,V1*
 07054 26 14583 14521 04000 CW24   TF    U1,UC,,       CW 2 TO 4*
 07066 26 14589 14531 04010        TF    V1,VC*
 07078 21 14589 14565 04020        A     V1,R*
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 I-ADD OP              P/L LABEL   OP      OPERANDS
07090 17 11050 000-0 04030        BTM   OUTPUT,0,10*
07102 26 14571 14583 04040        TF    U0,U1*
07114 26 14577 14589 04050        TF    V0,V1*
07126 26 14583 14521 04060 CW14   TF    U1,UC*
07138 21 14583 14565 04070        A     U1,R*
07150 26 14589 14531 04080        TF    V1,VC*
07162 17 11050 000-0 04090        BTM   OUTPUT,0,10*
07174 26 14571 14583 04100        TF    U0,U1*
07186 26 14577 14589 04110        TF    V0,V1*
07198 49 05746 00000 04120        B     CW11SH,,,     OUTPUT LAST POINT IN 4*
07210 26 14583 14521 04130 CCW14  TF    U1,UC,,       CCW 1 TO 4*
07222 26 14589 14531 04140        TF    V1,VC*
07234 21 14589 14565 04150        A     V1,R*
07246 17 11050 000-0 04160        BTM   OUTPUT,0,10*
07258 26 14571 14583 04170        TF    U0,U1*
07270 26 14577 14589 04180        TF    V0,V1*
07282 26 14583 14521 04190 CCW24  TF    U1,UC,,       CCW 2 TO 4*
07294 22 14583 14565 04200        S     U1,R*
07306 26 14589 14531 04210        TF    V1,VC*
07318 17 11050 000-0 04220        BTM   OUTPUT,0,10*
07330 26 14571 14583 04230        TF    U0,U1*
07342 26 14577 14589 04240        TF    V0,V1*
07354 26 14583 14521 04250 CCW34  TF    U1,UC*
07366 26 14589 14531 04260        TF    V1,VC*
07378 22 14589 14565 04270        S     V1,R*
07390 17 11050 000-0 04280        BTM   OUTPUT,0,10*
07402 26 14571 14583 04290        TF    U0,U1*
07414 26 14577 14589 04300        TF    V0,V1*
07426 49 05746 00000 04310        B     CW11SH,,,     OUTPUT LAST POINT IN 4CCW*
07438 44 06370 14240 04320 P01Q42 BNF   CCW42,DIREC*
07450 49 06142 00000 04330        B     CW42*
07462 44 06754 14240 04340 P01Q43 BNF   CCW43,DIREC*
07474 49 06670 00000 04350        B     CW43*
07486 14 14535 000-2 04360 P0QD3  CM    P1QUAD,2,10*
07498 47 07534 01200 04370        BNE   *&36*
07510 44 06298 14240 04380        BNF   CCW32,DIREC*
07522 49 06214 00000 04390        B     CW32*
07534 14 14535 000-1 04400        CM    P1QUAD,1,10*
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I-ADD OP                P/L LABEL   OP      OPERANDS

07546 47 07582 01200 04410          BNE     *&36*
07558 44 05914 14240 04420          BNF     CCW31,DIREC*
07570 49 05602 00000 04430          B       CW31*
07582 44 07354 14240 04440          BNF     CCW34,DIREC*
07594 49 06982 00000 04450          B       CW34*
07606 14 14535 000-1 04460 POQD2    CM      P1QUAD,1,10*
07618 47 07654 01200 04470          BNE     *&36*
07630 44 05842 14240 04480          BNF     CCW21,DIREC*
07642 49 05674 00000 04490          B       CW21*
07654 14 14535 000-4 04500          CM      P1QUAD,4,10*
07666 47 07702 01200 04510          BNE     *&36*
07678 44 07282 14240 04520          BNF     CCW24,DIREC*
07690 49 07054 00000 04530          B       CW24*
07702 44 06898 14240 04540          BNF     CCW23,DIREC*
07714 49 06526 00000 04550          B       CW23*
07726 14 14535 000-4 04560 POQD1    CM      P1QUAD,4,10*
07738 47 07774 01200 04570          BNE     *&36*
07750 44 07210 14240 04580          BNF     CCW14,DIREC*
07762 49 07126 00000 04590          B       CW14*
07774 14 14535 000-3 04600          CM      P1QUAD,3,10*
07786 47 07822 01200 04610          BNE     *&36*
07798 44 06826 14240 04620          BNF     CCW13,DIREC*
07810 49 06598 00000 04630          B       CW13*
07822 44 06442 14240 04640          BNF     CCW12,DIREC*
07834 49 06070 00000 04650          B       CW12*
07846 14 14533 000-1 04660 SAMEQD   CM      P0QUAD,1,10*
07858 47 08086 01200 04670          BNE     NEXT2*
07870 24 14571 14583 04680          C       U0,U1*
07882 44 07990 14240 04690          BNF     *&108,DIREC*
07894 47 05746 01300 04700          BN      CW11SH*
07906 26 14583 14521 04710          TF      U1,UC,,         LONG WAY AROUND*
07918 21 14583 14565 04720          A       U1,R*
07930 26 14569 14531 04730          TF      V1,VC*
07942 17 11050 000-0 04740          BTM     OUTPUT,0,10*
07954 26 14571 14583 04750          TF      U0,U1*
07966 26 14577 14589 04760          TF      V0,V1*
07978 49 05530 00000 04770          B       CW41*
07990 46 05746 01100 04780          BP      CW11SH*
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I-ADD OP              P/L LABEL   OP      OPERANDS

08002 26 14583 14521 04790        TF    U1,UC,,       LONG WAY AROUND*
08014 26 14589 14531 04800        TF    V1,VC*
08026 21 14589 14565 04810        A     V1,R*
08038 17 11050 000-0 04820        BTM   OUTPUT,0,10*
08050 26 14571 14583 04830        TF    U0,U1*
08062 26 14577 14589 04840        TF    V0,V1*
08074 49 05842 00000 04850        B     CCW21*
08086 14 14533 000-2 04860 NEXT2  CM    POQUAD,2,10*
08098 47 08326 01200 04870        BNE   NEXT3*
08110 24 14577 14589 04880        C     V0,V1*
08122 44 08230 14240 04890        BNF   *&108,DIREC*
08134 47 05746 01300 04900        BN    CW11SH*
08146 26 14583 14521 04910        TF    U1,UC,,       LONG WAY AROUND*
08158 26 14589 14531 04920        TF    V1,VC*
08170 21 14589 14565 04930        A     V1,R*
08182 17 11050 000-0 04940        BTM   OUTPUT,0,10*
08194 26 14571 14583 04950        TF    U0,U1*
08206 26 14577 14589 04960        TF    V0,V1*
08218 49 06070 00000 04970        B     CW12*
08230 46 05746 01100 04980        BP    CW11SH*
08242 26 14583 14521 04990        TF    U1,UC,,       LONG WAY AROUND*
08254 22 14583 14565 05000        S     U1,R*
08266 26 14589 14531 05010        TF    V1,VC*
08278 17 11050 000-0 05020        BTM   OUTPUT,0,10*
08290 26 14571 14583 05030        TF    U0,U1*
08302 26 14577 14589 05040        TF    V0,V1*
08314 49 06298 00000 05050        B     CCW32*
08326 14 14533 000-3 05060 NEXT3  CM    POQUAD,3,10*
08338 47 08566 01200 05070        BNE   NEXT4*
08350 24 14571 14583 05080        C     U0,U1*
08362 44 08470 14240 05090        BNF   *&108,DIREC*
08374 46 05746 01100 05100        BP    CW11SH*
08386 26 14583 14521 05110        TF    U1,UC,,       LONG WAY AROUND*
08398 22 14583 14565 05120        S     U1,R*
08410 26 14589 14531 05130        TF    V1,VC*
08422 17 11050 000-0 05140        BTM   OUTPUT,0,10*
08434 26 14571 14583 05150        TF    U0,U1*
08446 26 14577 14589 05160        TF    V0,V1*
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 I-ADD OP              P/L LABEL   OP      OPERANDS
08458 49 06526 00000 05170         B       CW23*
08470 47 05746 01300 05180         BN      CW11SH*
08482 26 14583 14521 05190         TF      U1,UC,,        LONG WAY AROUND*
08494 26 14589 14531 05200         TF      V1,VC*
08506 22 14589 14565 05210         S       V1,R*
08518 17 11050 000-0 05220         BTM     OUTPUT,0,10*
08530 26 14571 14583 05230         TF      U0,U1*
08542 26 14577 14589 05240         TF      V0,V1*
08554 49 06754 00000 05250         B       CCW43*
08566 24 14571 14583 05260 NEXT4   C       U0,U1*
08578 44 08686 14240 05270         BNF     *&108,DIREC*
08590 46 05746 01100 05280         BP      CW11SH*
08602 26 14583 14521 05290         TF      U1,UC,,        LONG WAY AROUND*
08614 26 14589 14531 05300         TF      V1,VC*
08626 22 14589 14565 05310         S       V1,R*
08638 17 11050 000-0 05320         BTM     OUTPUT,0,10*
08650 26 14571 14583 05330         TF      U0,U1*
08662 26 14577 14589 05340         TF      V0,V1*
08674 49 06982 00000 05350         B       CW34*
08686 47 05746 01300 05360         BN      CW11SH*
08698 26 14583 14521 05370         TF      U1,UC,,        LONG WAY AROUND*
08710 21 14583 14565 05380         A       U1,R*
08722 26 14589 14531 05390         TF      V1,VC*
08734 17 11050 000-0 05400         BTM     OUTPUT,0,10*
08746 26 14571 14583 05410         TF      U0,U1*
08758 26 14577 14589 05420         TF      V0,V1*
08770 49 07210 00000 05430         B       CCW14*
08778                05440         DORG    *-3*
08778 24 13815 14175 05450 LINE    C       A&19,NIL*
08790 47 08814 01200 05460         BNE     *&24*
08802 26 13815 14115 05470         TF      A&19,FLTO*
08814 24 13825 14175 05480         C       A&29,NIL*
08826 47 08850 01200 05490         BNE     *&24*
08838 26 13825 14115 05500         TF      A&29,FLTO*
08850 44 08874 15120 05510         BNF     *&24,ROTRAN*
08862 17 17460 000R9 05520         BTM     LINROT,99,10*
08874 14 13795 0-001 05530         CM      CNTR,1,8,CHECK TO SEE IF CARD IS 001*
08886 47 09122 01200 05540         BNE     NOTONE*
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1-ADD OP                P/L LABEL    OP       OPERANDS

08898 44 08922 08778 05550          BNF    *&24,LINE*
08910 49 09122 00000 05560          B      NOTONE*
08922 26 13753 13815 05570          TF     FLTING,A&19,,IF 001, CONVERT AND STORE ...THEN READ AGAIN*
08934 17 13526 000-0 05580          BTM    FLTOFX,0,10*
08946 32 13754 00000 05590          SF     FIXED-14*
08958 26 14345 13760 05600          TF     WORK,FIXED-8*
08970 11 14345 000-5 05610          AM     WORK,5,10*
08982 71 14344 14345 05620          MF     WORK-1,WORK*
08994 26 14182 14344 05630          TF     XOFXRD,WORK-1*
09006 26 14125 13815 05640          TF     XO,A&19*
09018 26 13753 13825 05650          TF     FLTING,A&29*
09030    13526 000-0 05660          BTM    FLTOFX,0,10*
09042    13754 00000 05670          SF     FIXED-14*
09054 26 14345 13760 05680          TF     WORK,FIXED-8*
09066 11 14345 000-5 05690          AM     WORK,5,10*
09078 71 14344 14345 05700          MF     WORK-1,WORK*
09090 26 14189 14344 05710          TF     YOFXRD,WORK-1*
09102 26 14135 13825 05720          TF     YO,A&29*
09114 49 02562 00000 05730          B      BEGIN*
09122                05740          DORG   *-3*
09122 26 13753 13815 05750 NOTONE   TF     FLTING,A&19*
09134 17 13526 000-0 05760          BTM    FLTOFX,0,10*
09146 32 13754 00000 05770          SF     FIXED-14*
09158 26 14345 13760 05780          TF     WORK,FIXED-8*
09170 11 14345 000-5 05790          AM     WORK,5,10*
09182 71 14344 14345 05800          MF     WORK-1,WORK*
09194 26 14145 14344 05810          TF     X1,WORK-1*
09206 26 14217 14145 05820          TF     TEMPX,X1*
09218 26 13753 13825 05830          TF     FLTING,A&29*
09230 17 13526 000-0 05840          BTM    FLTOFX,0,10*
09242 32 13754 00000 05850          SF     FIXED-14*
09254 26 14345 13760 05860          TF     WORK,FIXED-8*
09266 11 14345 000-5 05870          AM     WORK,5,10*
09278 71 14344 14345 05880          MF     WORK-1,WORK*
09290 26 14155 14344 05890          TF     Y1,WORK-1*
09302 26 14224 14155 05900          TF     TEMPY,Y1*
09314 22 14145 14182 05910          S      X1,XOFXRD*
09326 22 14155 14189 05920          S      Y1,YOFXRD*
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I-ADD OP              P/L LABEL   OP       OPERANDS

09338 26 14205 14145 05930        TF     DELTAX,X1#
09350 26 14210 14155 05940        TF     DELTAY,Y1#
09362 26 14145 13815 05950        TF     X1,A&19,,FEED RATE CALCULATIONS#
09374 26 14155 13825 05960        TF     Y1,A&29#
09386 16 00469 -9421 05970        FS     X1,X0#
09398 16 00445 J4145
09410 49 00402 J4125
09422 16 00469 -9457 05980        FS     Y1,Y0#
09434 16 00445 J4155
09446 49 00402 J4135
09458 16 00469 -9493 05990        FM     X1,X1#
09470 26 01260 14145
09482 49 01262 J4145
09494 26 14145 00099 06000        TF     X1,99#
09506 16 00469 -9541 06010        FM     Y1,Y1#
09518 26 01260 14155
09530 49 01262 J4155
09542 26 14155 00099 06020        TF     Y1,99#
09554 16 00469 -9589 06030        FA     Y1,X1#
09566 16 00445 J4155
09578 49 00422 J4145
09590 24 14155 14115 06040        C      Y1,FLT0#
09602 47 09634 01200 06050        BNE    *&32#
09614 16 14165 0-000 06060        TFM    FEED,0,8, SET FEEDRATE TO 0  IF DELTA TERM IS 0#
09626 49 09890 00000 06070        B      NOCONV#
09634                06080        DORG   *-3#
09634 16 18666 -9669 06090        FSQR   Y1,Y1#
09646 16 18654 J4155
09658 49 18140 J4155
09670 26 14165 14105 06100 GOBAC  TF     FEED,FDRATE#
09682 26 14833 14155 06110        TF     SAVE,Y1#
09694 16 00469 -9729 06120        FD     FEED,Y1#
09706 26 01260 14165
09718 49 01422 J4155
09730 26 14165 00099 06130        TF     FEED,99#
09742 24 14165 14335 06140        C      FEED,FE5,,CHECK FEEDRATE LESS THEAN 5000#
09754 47 09830 01300 06150        BN     CONV#
09766 24 14165 14399 06160        C      FEED,FE81#
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 I-ADD OP              P/L LABEL   OP      OPERANDS

09778 47 09810 01200 06170         BNE   *&32*
09790 16 14165 0Q100 06180         TFM   FEED,8100,8*
09802 49 09890 00000 06190         B     NOCONV*
09810                06200         DORG  *-3*
09810 16 14165 0N000 06210         TFM   FEED,5000,8*
09822 49 09890 00000 06220         B     NOCONV*
09830                06230         DORG  *-3*
09830 26 13753 14165 06240 CONV    TF    FLTING,FEED*
09842 17 13526 000-0 06250         BTM   FLTOFX,0,10*
09854 32 13754 00000 06260         SF    FIXED-14*
09866 26 14345 13760 06270         TF    WORK,FIXED-8*
09878 26 14165 14343 06280         TF    FEED,WORK-2,,MULT BY 100*
09890 26 14125 13815 06290 NOCONV  TF    X0,A&19*
09902 26 14135 13825 06300         TF    Y0,A&29*
09914 44 09974 02562 06310         BNF   *&60,BEGIN*
09926 26 18089 14105 06320         TF    FSAVE,FDRATE*
09938 26 14105 19797 06330         TF    FDRATE,F100
09950 16 09915 000M9 06340         TFM   NCCONV&25,49,10*
09962 49 09670 00000 06350         B     GOBAC*
09974 26 14182 14217 06360         TF    XOFXRD,TEMPX*
09986 26 14189 14224 06370         TF    YOFXRD,TEMPY*
09998 47 10094 00400 06380         BNC4  SKIP2*
10010 16 00469 J0045 06390 NOTRAP  FA    LENGTH,SAVE*
10022 16 00445 J4759
10034 49 00422 J4833
10046 21 14783 14203 06400         A     SUMDX,DELTAX*
10058 21 14793 14210 06410         A     SUMDY,DELTAY*
10070 43 12544 14205 06420         BD    ER3,DELTAY-5*
10082 43 12544 14198 06430         BD    ER3,DELTAX-5*
10094 44 10138 14203 06440 SKIP2   BNF   *&44,DELTAX*
10106 33 14203 00000 06450         CF    DELTAX*
10118 15 14406 00002 06460         TDM   G1&5,2*
10130 49 10150 00000 06470         B     *&20*
10138                06480         DORG  *-3*
10138 15 14406 00000 06490         TDM   G1&5,0*
10150 25 14409 14199 06500         TD    G1&8,DELTAX-4*
10162 25 14411 14200 06510         TD    G1&10,DELTAX-3*
10174 25 14413 14201 06520         TD    G1&12,DELTAX-2*
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I-ADD OP              P/L LABEL   OP      OPERANDS

10186 25 14415 14202 06530        TD     G1&14,DELTAX-1*
10198 25 14417 14203 06540        TD     G1&16,DELTAX*
10210 44 10254 14210 06550        BNF    *&44,DELTAY*
10222 33 14210 00000 06560        CF     DELTAY*
10234 15 14420 00002 06570        TDM    G1&19,2*
10246 49 10266 00000 06580        B      *&20*
10254                06590        DORG   *-3*
10254 15 14420 00000 06600        TDM    G1&19,0*
10266 25 14423 14206 06610        TD     G1&22,DELTAY-4*
10278 25 14425 14207 06620        TD     G1&24,DELTAY-3*
10290 25 14427 14208 06630        TD     G1&26,DELTAY-2*
10302 25 14429 14209 06640        TD     G1&28,DELTAY-1*
10314 25 14431 14210 06650        TD     G1&30,DELTAY*
10326 25 14435 14162 06660        TD     G1&34,FEED-3*
10338 25 14437 14163 06670        TD     G1&36,FEED-2*
10350 25 14439 14164 06680        TD     G1&38,FEED-1*
10362 25 14441 14165 06690        TD     G1&40,FEED*
10374 47 10410 00100 06700        BNC1   PNCHG1*
10386 34 00000 00102 06710        RCTY    *
10398 39 14401 00100 06720        WATY   G1*
10410 47 10434 00200 06730 PNCHG1 BNC2   *&24*
10422 39 14401 00200 06740        WAPT   G1*
10434 44 02562 02562 06750        BNF    BEGIN,BEGIN*
10446 26 14105 18089 06760        TF     FDRATE,FSAVE*
10458 33 02562 00000 06770        CF     BEGIN*
10470 16 09915 000M4 06780        TFM    NOCONV&25,44,10*
10482 49 02562 00000 06790        B      BEGIN*
10492                06800        DORG   *-1*
10492 24 14541 14555 06810 FINDQD C      ARGX,ARG0,,    SUBROUTINE TO FIND QUADRANT*
10504 46 10840 01200 06820        BE     ARX0,,,        GO TO X#0 ROUTINE*
10516 47 10684 01300 06830        BN     ARXNEG,,,      GO TO X NEG ROUTINE*
10528 24 14547 14555 06840        C      ARGY,ARG0,,    X POS ROUTINE*
10540 46 10592 01200 06850        BE     ARY0P,,,       GO TO X POS, Y#0 ROUTINE*
10552 47 10578 01300 06860        BN     *&26*
10564 16 14549 000-1 06870        TFM    QUAD,1,10,     Q1 IF X POS, Y POS*
10576 42 00000 00000 06880        BB      *
10578                06890        DORG   *-9*
10578 16 14549 000-4 06900        TFM    QUAD,4,10,     Q4 IF X POS, Y NEG*
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I-ADD OP              P/L LABEL   OP      OPERANDS

10590 42 00000 00000 06910        BB      *
10592                06920        DORG    *-9*
10592 44 10644 14240 06930 ARYOP  BNF     *&52,DIREC*
10604 44 10630 15106 06940        BNF     *&26,POIND*
10616 16 14549 000-4 06950        TFM     QUAD,4,10,     Q4 IF X POS, Y#0, CW, P0*
10628 42 00000 00000 06960        BB      *
10630                06970        DORG    *-9*
10630 16 14549 000-1 06980        TFM     QUAD,1,10,     Q1 IF X POS#   Y#0, CW, P1*
10642 42 00000 00000 06990        BB      *
10644                07000        DORG    *-9*
10644 44 10670 15106 07010        BNF     *&26,POIND*
10656 16 14549 000-1 07020        TFM     QUAD,1,10,     Q1 IF X POS, Y#0, CCW, P0*
10668 42 00000 00000 07030        BB      *
10670                07040        DORG    *-9*
10670 16 14549 000-4 07050        TFM     QUAD,4,10,     Q4 IF X POS, Y#0, CCW, P1*
10682 42 00000 00000 07060        BB      *
10684                07070        DORG    *-9*
10684 24 14547 14555 07080 ARXNEG C       ARGY,ARG0*
10696 46 10748 01200 07090        BE      ARYON,,,       GO TO X NEG, Y#0*
10708 47 10734 01300 07100        BN      *&26*
10720 16 14549 000-2 07110        TFM     QUAD,2,10,     Q2 IF X NEG,Y POS*
10732 42 00000 00000 07120        BB      *
10734                07130        DORG    *-9*
10734 16 14549 000-3 07140        TFM     QUAD,3,10,     Q3 IF X NEG,Y NEG*
10746 42 00000 00000 07150        BB      *
10748                07160        DORG    *-9*
10748 44 10800 14240 07170 ARYON  BNF     *&52,DIREC*
10760 44 10786 15106 07180        BNF     *&26,POIND*
10772 16 14549 000-2 07190        TFM     QUAD,2,10,     Q2 IF X NEG, Y#0, CW, P0*
10784 42 00000 00000 07200        BB      *
10786                07210        DORG    *-9*
10786 16 14549 000-3 07220        TFM     QUAD,3,10,     Q3 IF X NEG, Y#0, CW, P1*
10798 42 00000 00000 07230        BB      *
10800                07240        DORG    *-9*
10800 44 10826 15106 07250        BNF     *&26,POIND*
10812 16 14549 000-3 07260        TFM     QUAD,3,10,     Q3 IF X NEG, Y#0, CCW, P0*
10824 42 00000 00000 07270        BB      *
10826                07280        DORG    *-9*
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I-ADD OP              P/L LABEL   OP      OPERANDS

10826 16 14549 000-2 07290        TFM   QUAD,2,10,    Q2 IF X NEG, Y#0, CCW, P1*
10838 42 00000 00000 07300        BB     *
10840                07310        DORG  *-9*
10840 24 14547 14555 07320 ARX0   C     ARGY,ARG0*
10852 47 10956 01300 07330        BN    *&104*
10864 44 10916 14240 07340        BNF   *&52,DIREC*
10876 44 10902 15106 07350        BNF   *&26,POIND*
10888 16 14549 000-1 07360        TFM   QUAD,1,10,    Q1 IF X#0, Y POS, CW, P0*
10900 42 00000 00000 07370        BB     *
10902                07380        DORG  *-9*
10902 16 14549 000-2 07390        TFM   QUAD,2,10,    Q2 IF X#0, Y POS, CW, P1*
10914 42 00000 00000 07400        BB     *
10916                07410        DORG  *-9*
10916 44 10942 15106 07420        BNF   *&26,POIND*
10928 16 14549 000-2 07430        TFM   QUAD,2,10,    Q2 IF X#0, Y POS, CCW, P0*
10940 42 00000 00000 07440        BB     *
10942                07450        DORG  *-9*
10942 16 14549 000-1 07460        TFM   QUAD,1,10,    Q1 IF X#0, Y POS, CCW, P1*
10954 42 00000 00000 07470        BB     *
10956                07480        DORG  *-9*
10956 44 11008 14240 07490        BNF   *&52,DIREC*
10968 44 10994 15106 07500        BNF   *&26,POIND*
10980 16 14549 000-3 07510        TFM   QUAD,3,10,    Q3 IF X#0, Y NEG, CW, P0*
10992 42 00000 00000 07520        BB     *
10994                07530        DORG  *-9*
10994 16 14549 000-4 07540        TFM   QUAD,4,10,    Q4 IF X#0, Y NEG, CW, P1*
11006 42 00000 00000 07550        BB     *
11008                07560        DORG  *-9*
11008 44 11034 15106 07570        BNF   *&26,POIND*
11020 16 14549 000-4 07580        TFM   QUAD,4,10,    Q4 IF X#0, Y NEG, CCW, P0*
11032 42 00000 00000 07590        BB     *
11034                07600        DORG  *-9*
11034 16 14549 000-3 07610        TFM   QUAD,3,10,    Q3 IF X#0, Y NEG, CCW, P1*
11046 42 00000 00000 07620        BB     *
11050                07630        DORG  *-7*
11050 26 14203 14583 07640 OUTPUT TF    DELTAX,U1,,   CIRCLE OUTPUT SUBROUTINE*
11062 22 14203 14571 07650        S     DELTAX,U0*
11074 26 14210 14589 07660        TF    DELTAY,V1*
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I-ADD OP                P/L LABEL   OP       OPERANDS

11086 22 14210 14577 07670          S       DELTAY,V0*
11098 26 14231 14571 07680          TF      OFSETX,U0*
11110 22 14231 14521 07690          S       OFSETX,UC*
11122 26 14238 14577 07700          TF      OFSETY,V0*
11134 22 14238 14531 07710          S       OFSETY,VC*
11146 47 12038 00400 07720          BNC4    SKIP*
11158 26 14803 14231 07730          TF      FIX,OFSETX*
11170 16 14823 J1190 07740          TFM     FLEXIT,*&20,7*
11182 49 12634 00000 07750          B       FXTOFL*
11190                07760          DORG    *-3*
11190 26 14689 14818 07770          TF      PX1,FLOAT*
11202 26 14803 14238 07780          TF      FIX,OFSETY*
11214 16 14823 J1234 07790          TFM     FLEXIT,*&20,7*
11226 49 12634 00000 07800          B       FXTOFL*
11234                07810          DORG    *-3*
11234 26 14709 14818 07820          TF      PY1,FLOAT*
11246 26 14803 14583 07830          TF      FIX,U1*
11258 22 14803 14521 07840          S       FIX,UC*
11270 16 14823 J1290 07850          TFM     FLEXIT,*&20,7*
11282 49 12634 00000 07860          B       FXTOFL*
11290                07870          DORG    *-3*
11290 26 14699 14818 07880          TF      PX2,FLOAT*
11302 26 14803 14589 07890          TF      FIX,V1*
11314 22 14803 14531 07900          S       FIX,VC*
11326 16 14823 J1346 07910          TFM     FLEXIT,*&20,7*
11338 49 12634 00000 07920          B       FXTOFL*
11346                07930          DORG    *-3*
11346 26 14719 14818 07940          TF      PY2,FLOAT*
11358 16 00469 J1393 07950          FM      PY2,PX1*
11370 26 01260 14719
11382 49 01262 J4689
11394 26 14719 00099 07960          TF      PY2,99*
11406 16 00469 J1441 07970          FM      PX2,PY1*
11418 26 01260 14699
11430 49 01262 J4709
11442 26 14699 00099 07980          TF      PX2,99*
11454 16 00469 J1489 07990          FS      PY2,PX2*
11466 16 00445 J4719
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 I-ADD OP              P/L LABEL   OP       OPERANDS

11478 49 00402 J4699
11490 26 14345 14719 08000         TF     WORK,PY2*
11502 16 00469 J1537 08010         FM     WORK,PY2*
11514 26 01260 14345
11526 49 01262 J4719
11538 26 14345 00099 08020         TF     WORK,99*
11550 32 14345 00000 08030         SF     WORK*
11562 26 14739 14729 08040         TF     FR1,FR*
11574 16 00469 J1609 08050         FM     FR1,FR1*
11586 26 01260 14739
11598 49 01262 J4739
11610 26 14739 00099 08060         TF     FR1,99*
11622 16 00469 J1657 08070         FM     FR1,FR1*
11634 26 01260 14739
11646 49 01262 J4739
11658 26 14739 00099 08080         TF     FR1,99*
11670 16 00469 J1705 08090         FA     WORK,FR1*
11682 16 00445 J4345
11694 49 00422 J4739
11706 33 14345 00000 08100         CF     WORK*
11718 16 18666 J1753 08110         FSQR   WORK,WORK*
11730 16 18654 J4345
11742 49 18140 J4345
11754 24 14345 14175 08120         C      WORK,NIL*
11766 47 11798 01200 08130         BNE    *&32*
11778 26 14345 15104 08140         TF     WORK,PIOER2*
11790 49 11846 00000 08150         B      *&56*
11798                08160         DORG   *-3*
11798 16 00469 J1833 08170         FD     PY2,WORK*
11810 26 01260 14719
11822 49 01422 J4345
11834 26 14719 00099 08180         TF     PY2,99*
11846 44 11870 14719 08190         BNF    *&24,PY2*
11858 33 14719 00000 08200         CF     PY2*
11870 16 19492 J1905 08210         FATN   WORK,PY2*
11882 16 19480 J4345
11894 49 18710 J4719
11906 16 00469 J1941 08220         FM     WORK,FR*
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                I-ADD OP                P/L LABEL    OP       OPERANDS

   11918 26 01260 14345
   11930 49 01262 J4729
   11942 26 14345 00099 08230          TF       WORK,99*
   11954 16 00469 J1989 08240          FA       LENGTH,WORK*
   11966 16 00445 J4759
   11978 49 00422 J4345
   11990 21 14783 14203 08250          A        SUMDX,DELTAX*
   12002 21 14793 14210 08260          A        SUMDY,DELTAY*
   12014 43 12588 14198 08270          BD       ER2,DELTAX-5*
   12026 43 12588 14205 08280          BD       ER2,DELTAY-5*
   12038 44 12070 14240 08290 SKIP     BNF      *&32,DIREC*
   12050 15 14447 00002 08300          TDM      G2&2,2*
   12062 49 12082 00000 08310          B        *&20*
   12070                08320          DORG     *-3*
   12070 15 14447 00003 08330          TDM      G2&2,3*
   12082 44 12126 14203 08340          BNF      *&44,DELTAX*
   12094 33 14203 00000 08350          CF       DELTAX*
   12106 15 14450 00002 08360          TDM      G2&5,2*
   12118 49 12138 00000 08370          B        *&20*
   12126                08380          DORG     *-3*
   12126 15 14450 00000 08390          TDM      G2&5,0*
   12138 25 14453 14199 08400          TD       G2&8,DELTAX-4*
   12150 25 14455 14200 08410          TD       G2&10,DELTAX-3*
   12162 25 14457 14201 08420          TD       G2&12,DELTAX-2*
   12174 25 14459 14202 08430          TD       G2&14,DELTAX-1*
   12186 25 14461 14203 08440          TD       G2&16,DELTAX*
   12198 44 12242 14210 08450          BNF      *&44,DELTAY*
   12210 33 14210 00000 08460          CF       DELTAY*
   12222 15 14464 00002 08470          TDM      G2&19,2*
   12234 49 12254 00000 08480          B        *&20*
   12242                08490          DORG     *-3*
   12242 15 14464 00000 08500          TDM      G2&19,0*
   12254 25 14467 14206 08510          TD       G2&22,DELTAY-4*
   12266 25 14469 14207 08520          TD       G2&24,DELTAY-3*
   12278 25 14471 14208 08530          TD       G2&26,DELTAY-2*
   12290 25 14473 14209 08540          TD       G2&28,DELTAY-1*
   12302 25 14475 14210 08550          TD       G2&30,DELTAY*
   12314 25 14479 14227 08560          TD       G2&34,OFSETX-4*
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 I-ADD OP              P/L LABEL   OP       OPERANDS

12326 25 14481 14228 08570         TD     G2&36,OFSETX-3*
12338 25 14483 14229 08580         TD     G2&38,OFSETX-2*
12350 25 14485 14230 08590         TD     G2&40,OFSETX-1*
12362 25 14487 14231 08600         TD     G2&42,OFSETX*
12374 25 14491 14234 08610         TD     G2&46,OFSETY-4*
12386 25 14493 14235 08620         TD     G2&48,OFSETY-3*
12398 25 14495 14236 08630         TD     G2&50,OFSETY-2*
12410 25 14497 14237 08640         TD     G2&52,OFSETY-1*
12422 25 14499 14238 08650         TD     G2&54,OFSETY*
12434 25 14503 14162 08660         TD     G2&58,FEED-3*
12446 25 14505 14163 08670         TD     G2&60,FEED-2*
12458 25 14507 14164 08680         TD     G2&62,FEED-1*
12470 25 14509 14165 08690         TD     G2&64,FEED*
12482 47 12518 00100 08700         BNC1   *&36,,,TYPE IF SWITCH 1 ON*
12494 34 00000 00102 08710         RCTY    *
12506 39 14445 00100 08720         WATY   G2*
12518 47 12542 00200 08730         BNC2   *&24,,,       PUNCH IF SWITCH 2 ON*
12530 39 14445 00200 08740         WAPT   G2*
12542 42 00000 00000 08750         BB      *
12544                08760         DORG   *-9*
12544 34 00000 00102 08770 ER3     RCTY    *
12556 39 14835 00100 08780         WATY   ERR2*
12568 48 00000 00000 08790         H       *
12580 49 10094 00000 08800         B      SKIP2*
12588                08810         DORG   *-3*
12588 34 00000 00102 08820 ER2     RCTY    *
12600 39 14835 00100 08830         WATY   ERR2*
12612 48 00000 00000 08840         H       *
12624 49 12038 00000 08850         B      SKIP*
12634                08860         DORG   *-1*
12634 26 14818 14115 08870 FXTOFL  TF     FLOAT,FLTO*
12646 43 13078 14798 08880         BD     SIX,FIX-5*
12658 43 13010 14799 08890         BD     FIVE,FIX-4*
12670 43 12942 14800 08900         BD     FOUR,FIX-3*
12682 43 12874 14801 08910         BD     THREE,FIX-2*
12694 43 12806 14802 08920         BD     TWO,FIX-1*
12706 43 12738 14803 08930         BD     ONE,FIX*
12718 26 14818 14115 08940         TF     FLOAT,FLTO*
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S.O.S.

 I-ADD OP                P/L LABEL   OP      OPERANDS

12730 49 1482L 00000 08950        B      FLEXIT,,6*
12738                08960        DORG   *-3*
12738 32 14802 00000 08970 ONE    SF     FIX-1*
12750 26 14811 14803 08980        TF     FLOAT-7,FIX*
12762 71 14818 14803 08990        MF     FLOAT,FIX*
12774 16 14810 000M8 09000        TFM    FLOAT-8,48,10*
12786 33 14811 00000 09010        CF     FLOAT-7*
12798 49 1482L 00000 09020        B      FLEXIT,,6*
12806                09030        DORG   *-3*
12806 32 14801 00000 09040 TWO    SF     FIX-2*
12818 26 14812 14803 09050        TF     FLOAT-6,FIX*
12830 71 14818 14803 09060        MF     FLOAT,FIX*
12842 16 14810 000M9 09070        TFM    FLOAT-8,49,10*
12854 33 14812 00000 09080        CF     FLOAT-6*
12866 49 1482L 00000 09090        B      FLEXIT,,6*
12874                09100        DORG   *-3*
12874 32 14800 00000 09110 THREE  SF     FIX-3*
12886 26 14813 14803 09120        TF     FLOAT-5,FIX*
12898 71 14818 14803 09130        MF     FLOAT,FIX*
12910 16 14810 000N0 09140        TFM    FLOAT-8,50,10*
12922 33 14813 00000 09150        CF     FLOAT-5*
12934 49 1482L 00000 09160        B      FLEXIT,,6*
12942                09170        DORG   *-3*
12942 32 14799 00000 09180 FOUR   SF     FIX-4*
12954 26 14814 14803 09190        TF     FLOAT-4,FIX*
12966 71 14818 14803 09200        MF     FLOAT,FIX*
12978 16 14810 000N1 09210        TFM    FLOAT-8,51,10*
12990 33 14814 00000 09220        CF     FLOAT-4*
13002 49 1482L 00000 09230        B      FLEXIT,,6*
13010                09240        DORG   *-3*
13010 32 14798 00000 09250 FIVE   SF     FIX-5*
13022 26 14815 14803 09260        TF     FLOAT-3,FIX*
13034 71 14818 14803 09270        MF     FLOAT,FIX*
13046 16 14810 000N2 09280        TFM    FLOAT-8,52,10*
13058 33 14815 00000 09290        CF     FLOAT-3*
13070 49 1482L 00000 09300        B      FLEXIT,,6*
13078                09310        DORG   *-3*
13078 32 14797 00000 09320 SIX    SF     FIX-6*

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 I-ADD OP              P/L LABEL   OP       OPERANDS

13090 33 14798 00000 09330         CF     FIX-5*
13102 26 14816 14803 09340         TF     FLOAT-2,FIX*
13114 71 14818 14803 09350         MF     FLOAT,FIX*
13126 16 14810 000N3 09360         TFM    FLOAT-8,53,10*
13138 33 14816 00000 09370         CF     FLOAT-2*
13150 49 1482L 00000 09380         B      FLEXIT,,6*
13160                09390         DORG   *-1*
13160 26 14818 14115 09400 FEEDFL  TF     FLOAT,FLTO*
13172 43 13444 14162 09410         BD     FFOUR,FEED-3*
13184 43 13376 14163 09420         BD     FTHREE,FEED-2*
13196 43 13308 14164 09430         BD     FTWO,FEED-1*
13208 43 13240 14165 09440         BD     FONE,FEED*
13220 26 14818 14115 09450         TF     FLOAT,FLTO*
13232 49 1482L 00000 09460         B      FLEXIT,,6*
13240                09470         DORG   *-3*
13240 32 14802 00000 09480 FONE    SF     FIX-1*
13252 26 14811 14803 09490         TF     FLOAT-7,FIX*
13264 71 14818 14803 09500         MF     FLOAT,FIX*
13276 16 14810 000N1 09510         TFM    FLOAT-8,51,10*
13288 16 14802 -0000 09520         TFM    FIX-1,0,7*
13300 49 1482L 00000 09530         B      FLEXIT,,6*
13308                09540         DORG   *-3*
13308 32 14801 00000 09550 FTWO    SF     FIX-2*
13320 26 14812 14803 09560         TF     FLOAT-6,FIX*
13332 71 14818 14803 09570         MF     FLOAT,FIX*
13344 16 14810 000N2 09580         TFM    FLOAT-8,52,10*
13356 16 14802 -0000 09590         TFM    FIX-1,0,7*
13368 49 1482L 00000 09600         B      FLEXIT,,6*
13376                09610         DORG   *-3*
13376 32 14800 00000 09620 FTHREE  SF     FIX-3*
13388 26 14813 14803 09630         TF     FLOAT-5,FIX*
13400 71 14818 14803 09640         MF     FLOAT,FIX*
13412 16 14810 000N3 09650         TFM    FLOAT-8,53,10*
13424 16 14802 000-0 09660         TFM    FIX-1,0,10*
13436 49 1482L 00000 09670         B      FLEXIT,,6*
13444                09680         DORG   *-3*
13444 32 14799 00000 09690 FFOUR   SF     FIX-4*
13456 33 14800 00000 09700         CF     FIX-3*
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6.0.0
  I-ADD OP              P/L LABEL   OP       OPERANDS

13468 26 14814 14803 09710         TF     FLOAT-4,FIX*
13480 71 14818 14803 09720         MF     FLOAT,FIX*
13492 16 14810 000N4 09730         TFM    FLOAT-8,54,10*
13504 16 14802 000-0 09740         TFM    FIX-1,0,10*
13516 49 1482L 00000 09750         B      FLEXIT,,6*
13526                09760         DORG   *-1*
13526 26 13760 13775 09770 FLTOFX  TF     FIXED-8,ZERO*
13538 14 13745 000M7 09780         CM     FLTING-8,47,10*
13550 47 13742 01300 09790         BL     FFEXIT*
13562 14 13745 000N4 09800         CM     FLTING-8,54,10*
13574 47 13646 01300 09810         BL     *&72*
13586 16 13789 -5771 09820         TFM    ERROR&12,5771*
13598 34 00000 00102 09830         RCTY    *
13610 39 13777 00100 09840         WATY   ERROR*
13622 48 00000 00000 09850         H       *
13634 49 02514 00000 09860         B      START*
13646 16 13736 J3807 09870         TFM    FFEXIT-6,FIXED&39*
13658 22 13736 13745 09880         S      FFEXIT-6,FLTING-8*
13670 44 13718 13753 09890         BNF    *&48,FLTING*
13682 16 13712 J3699 09900         TFM    *&30,FLTING-54*
13694 21 13712 13745 09910         A      *&18,FLTING-8*
13706 32 00000 00000 09920         SF      *
13716    00001       09930 RM      DC     1,a,*-1*
09930*                                                    -6J3716J3717-
13718 25 13753 13716 09940         TD     FLTING,RM*
13730 31 00000 13746 09950         TR     0,FLTING-7*
13742 42 00000 00000 09960 FFEXIT  BB      *
13753    00010       09970 FLTING  DS     10,**
13768    00015       09980 FIXED   DS     15*
13775    00007       09990 ZERO    DC     7,0*
09990-000000*                                              -6J3769J3776-
13777    00008       10000 ERROR   DAC    8,ERR    a,,ERRP1 PRINTED IF NO. IS LARGER THAN 1000*
10000M559590000000000*                                     -6J3776J3792-
13795    00004       10010 CNTR    DS     4*
13875    00080       10020 ANUMIC  DS     80*
13796    00080       10030 A       DS     80,ANUMIC-79*
13877    00100       10040 AREA    DAS    100*
14077    00010       10050 EXCUTE  DAC    10,LOAD DATA@*
```

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I-ADD OP              P/L LABEL   OP       OPERANDS

10050N3564144004441634l0*                                          -6J4076J4096-
14105     00010       10060 FDRATE DS     10*
14115     00010       10070 FLTO   DC     10,5000000000*
10070N000000000*                                                   -6J4106J4116-
14125     00010       10080 XO     DS     10*
14135     00010       10090 YO     DS     10*
14145     00010       10100 X1     DS     10*
14155     00010       10110 Y1     DS     10*
14165     00010       10120 FEED   DS     10*
14175     00010       10130 NIL    DC     10,0*
10130-000000000*                                                   -6J4166J4176-
14182     00007       10140 XOFXRD DS     7*
14189     00007       10150 YOFXRD DS     7*
14196     00007       10160 NIL7   DC     7,0*
10160-000000*                                                      -6J4190J4197-
14203     00007       10170 DELTAX DS     7*
14210     00007       10180 DELTAY DS     7*
14217     00007       10190 TEMPX  DS     7*
14224     00007       10200 TEMPY  DS     7*
14231     00007       10210 OFSETX DS     7*
14238     00007       10220 OFSETY DS     7*
14240     00002       10230 DIREC  DS     2*
14243     00004       10240 END    DAC    4,END@*
10240M555440*                                                      -6J4242J4250-
14251     00005       10250 FINI   DAC    5,FINI@*
10250M64955490*                                                    -6J4250J4260-
14261     00018       10260 ERR4   DAC    18,INVALID CARD CODE@*
10260M955654153494400434159440043564445O*                          -6J4260J4296-
14297     00015       10270 ERR3   DAC    15,SEQUENCE ERROR@*
10270024558644555434500459595659O*                                 -6J4296J4326-
14335     00010       10280 FE5    DC     10,5250000000*
10280N250000000*                                                   -6J4326J4336-
14345     00010       10290 WORK   DS     10*
14347     00022       10300 ERR5   DAC    22,05 DOES NOT FOLLOW 06@*
10300P07500445645620055566300465653535660070760*                  -6J4346J4390-
14399     00010       10310 FE81   DC     10,5281000000*
10310N281000000*                                                   -6J4390J4400-
14401     00022       10320 G1     DAC    22,G1X&00000Y&00000F0000@*
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I-60.  OP          P/L LABEL   OP          URSKANUS
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 I-ADD OP              P/I LABEL   OP        OP ADDR
 0-0-5

 14773     00001         10630         DAC    1,1*
 10620-*                                                          -6J4772J4774-
 14774     00010         10630 SUMUX   DS     10*
 14784     00010         10640 SUMDY   DS     10*
 14804     00010         10650 FIX     DS     10*
 14814     00015         10660 FLOAT   DS     15*
 14923     00005         10670 FLSXIT  DC     5*
 14933     00010         10680 SAVE    DS     10*
 14943     00028         10690 ERRZ    DAC    28,DELTA MOTION EXCEEDS ZERO*
 10690M4455364100545664956550056743454548e2007970379*             -6J4834J4844-
 10690:9790*                                                      -6J4884J4894-
 14971     00023         10700 SUMX    DAC    23,DELTA X SUM #      .   @*
 10700M4455364100870062645400530000000000300000000*               -6J4940J4956-
 14994     00023         10710 SUMY    DAC    23,DELTA Y SUM #      .   @*
 10710M4455364100680062645400330000000000300003000*               -6J4936J4962-
 15017     00000         10720 SX1     DS     ,SUMXL34*
 15025     00000         10730 SX2     DS     ,SX1A8*
 15033     00000         10740 SY1     DS     ,SUMYL34*
 15041     00000         10750 SY2     DS     ,SY1A8*
 15049     00010         10760 SUMDXF  DS     10*
 15059     00010         10770 SUMDYF  DS     10*
 15069     00019         10780 MES1    DAC    19,LENGTH OF PATH #  @*
 10780N5455547634800564600574163450023000000*                     -6J5002J5040-
 15041     00017         10790 MES2    DAC    17,CUTTING TIME #  @*
 10790M3646366345547006345445003300000*                           -6J5046J5074-
 15083     00010         10800 FLENGT  DS     10*
 15084     00001       . 10810         DC     1,@*
 10810*                                                           -6J5084J5085-
 15094     00010         10820 FTIME   DS     10*
 15104     00010         10830 PIOIRZ  DC     10,3115707963*
 10830N3115707963*                                                -6J5095J5105-
 15106     00002         10840 POINT   DS     2*
 15108  32 17466 00000 10850         SF     LINROT,,,MEANS INVERT*
 15120  32 15120 00000 10860 ROTRAN  SF     ROTRAN,,,STORES TRANSLATION AND ROTATION INFO*
 15132  32 13800 00000 10870         SF     A84*
 15144  32 13807 00000 10880         SF     A812*
 15156  32 13816 00000 10890         SF     A820*
 15168  32 13824 00000 10900         SF     A826*

 B-0-5-B
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I-ADD OP                P/L LABEL   OP      OPERANDS

15180 32 13832 00000 10910          SF      A&36#
15192 32 13840 00000 10920          SF      A&44#
15204 32 13848 00000 10930          SF      A&52#
15216 26 14803 13805 10940          TF      FIX,A&9#
15228 16 14823 J5248 10950          TFM     FLEXIT,*&20,7#
15240 49 12634 00000 10960          B       FXTOFL#
15248                10970          DORG    *-3#
15248 26 18049 14818 10980          TF      SCALE,FLOAT#
15260 26 14803 13813 10990          TF      FIX,A&17#
15272 16 14823 J5292 11000          TFM     FLEXIT,*&20,7#
15284 49 12634 00000 11010          B       FXTOFL#
15292                11020          DORG    *-3#
15292 26 14689 14818 11030          TF      PX1,FLOAT#
15304 26 14803 13821 11040          TF      FIX,A&25#
15316 16 14823 J5336 11050          TFM     FLEXIT,*&20,7#
15328 49 12634 00000 11060          B       FXTOFL#
15336                11070          DORG    *-3#
15336 26 14709 14818 11080          TF      PY1,FLOAT#
15348 26 14803 13829 11090          TF      FIX,A&33#
15360 16 14823 J5380 11100          TFM     FLEXIT,*&20,7#
15372 49 12634 00000 11110          B       FXTOFL#
15380                11120          DORG    *-3#
15380 26 14699 14818 11130          TF      PX2,FLOAT#
15392 26 14803 13837 11140          TF      FIX,A&41#
15404 16 14823 J5424 11150          TFM     FLEXIT,*&20,7#
15416 49 12634 00000 11160          B       FXTOFL#
15424                11170          DORG    *-3#
15424 26 14719 14818 11180          TF      PY2,FLOAT#
15436 26 14803 13845 11190          TF      FIX,A&49#
15448 16 14823 J5468 11200          TFM     FLEXIT,*&20,7#
15460 49 12634 00000 11210          B       FXTOFL#
15468                11220          DORG    *-3#
15468 26 17959 14818 11230          TF      PX1T,FLOAT#
15480 26 14803 13853 11240          TF      FIX,A&57#
15492 16 14823 J5512 11250          TFM     FLEXIT,*&20,7#
15504 49 12634 00000 11260          B       FXTOFL#
15512                11270          DORG    *-3#
15512 26 17979 14818 11280          TF      PY1T,FLOAT#
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I-ADD OP                P/L LABEL   OP      OPERANDS

15524 44 15624 17460 11290          BNF     *&100,LINROT*
15536 44 15568 14709 11300          BNF     *&32,PY1*
15548 33 14709 00000 11310          CF      PY1*
15560 49 15580 00000 11320          B       *&20*
15568                    11330      DORG    *-3*
15568 32 14709 00000 11340          SF      PY1*
15580 44 15612 14719 11350          BNF     *&32,PY2*
15592 33 14719 00000 11360          CF      PY2*
15604 49 15624 00000 11370          B       *&20*
15612                    11380      DORG    *-3*
15612 32 14719 00000 11390          SF      PY2*
15624 26 18039 14689 11400          TF      FAC,PX1*
15636 16 00469 J5671 11410          FS      FAC,PX2*
15648 16 00445 J8039
15660 49 00402 J4699
15672 16 00469 J5707 11420          FM      FAC,FAC*
15684 26 01260 18039
15696 49 01262 J8039
15708 26 14345 00099 11430          TF      WORK,99*
15720 26 18039 14709 11440          TF      FAC,PY1*
15732 16 00469 J5767 11450          FS      FAC,PY2*
15744 16 00445 J8039
15756 49 00402 J4719
15768 16 00469 J5803 11460          FM      FAC,FAC*
15780 26 01260 18039
15792 49 01262 J8039
15804 16 00469 J5839 11470          FA      WORK,99*
15816 16 00445 J4345
15828 49 00422 -0099
15840 44 16132 13864 11480          BNF     TRAN1,A&68*
15852 32 13856 00000 11490          SF      A&60*
15864 26 14803 13861 11500          TF      FIX,A&65*
15876 16 14823 J5896 11510          TFM     FLEXIT,*&20,7*
15888 49 12634 00000 11520          B       FXTOFL*
15896                    11530      DORG    *-3*
15896 26 17969 14818 11540          TF      PX2T,FLOAT*
15908 26 18039 17959 11550          TF      FAC,PX1T*
15920 16 00469 J5955 11560          FS      FAC ,PX2T*
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 I-ADD OP              P/L LABEL   OP       OPERANDS

15932 16 00445 J8039
15944 49 00402 J7969
15956 16 00469 J5991 11570         FM     FAC ,FAC*
15968 26 01260 18039
15980 49 01262 J8039
15992 16 00469 J6027 11580         FS     WORK,99*
16004 16 00445 J4345
16016 49 00402 -0099
16028 16 18666 J6063 11590         FSQR   PY2T,WORK*
16040 16 18654 J7989
16052 49 18140 J4345
16064 44 16088 13862 11600         BNF    *&24,A&66*
16076 32 17989 00000 11610         SF     PY2T*
16088 16 00469 J6123 11620         FA     PY2T,PY1T*
16100 16 00445 J7989
16112 49 00422 J7979
16124 49 16404 00000 11630         B      TRAN2*
16132                11640         DORG   *-3*
16132 32 13864 00000 11650 TRAN1   SF     A&68*
16144 26 14803 13869 11660         TF     FIX,A&73*
16156 16 14823 J6176 11670         TFM    FLEXIT,*&20,7*
16168 49 12634 00000 11680         B      FXTOFL*
16176                11690         DORG   *-3*
16176 26 17989 14818 11700         TF     PY2T,FLOAT*
16188 26 18039 17979 11710         TF     FAC,PY1T*
16200 16 00469 J6235 11720         FS     FAC ,PY2T*
16212 16 00445 J8039
16224 49 00402 J7989
16236 16 00469 J6271 11730         FM     FAC,FAC*
16248 26 01260 18039
16260 49 01262 J8039
16272 16 00469 J6307 11740         FS     WORK,99*
16284 16 00445 J4345
16296 49 00402 -0099
16308 16 18666 J6343 11750         FSQR   PX2T,WORK*
16320 16 18654 J7969
16332 49 18140 J4345
16344 44 16368 13862 11760         BNF    *&24,A&66*
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 I-ADD OP              P/L LABEL   OP       OPERANDS

16356 32 17969 00000 11770         SF     PX2T*
16368 16 00469 J6403 11780         FA     PX2T,PX1T*
16380 16 00445 J7969
16392 49 00422 J7959
16404 16 00469 J6439 11790 TRAN2   FS     PY2,PY1*
16416 16 00445 J4719
16428 49 00402 J4709
16440 16 00469 J6475 11800         FS     PX2,PX1*
16452 16 00445 J4699
16464 49 00402 J4689
16476 16 00469 J6511 11810         FM     PY2,PY2*
16488 26 01260 14719
16500 49 01262 J4719
16512 26 14833 00099 11820         TF     SAVE,99*
16524 16 00469 J6559 11830         FM     PX2,PX2*
16536 26 01260 14699
16548 49 01262 J4699
16560 16 00469 J6595 11840         FA     SAVE,99*
16572 16 00445 J4833
16584 49 00422 -0099
16596 16 00469 J6631 11850         FS     PX2T,PX1T*
16608 16 00445 J7969
16620 49 00402 J7959
16632 16 00469 J6667 11860         FS     PY2T,PY1T*
16644 16 00445 J7989
16656 49 00402 J7979
16668 16 00469 J6703 11870         FM     PY2T,PX2*
16680 26 01260 17989
16692 49 01262 J4699
16704 26 18039 00099 11880         TF     FAC,99*
16716 16 00469 J6751 11890         FM     PY2,PX2T*
16728 26 01260 14719
16740 49 01262 J7969
16752 16 00469 J6787 11900         FS     FAC,99*
16764 16 00445 J8039
16776 49 00402 -0099
16788 16 00469 J6823 11910         FD     FAC,SAVE*
16800 26 01260 18039
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 I-ADD OP              P/L LABEL   OP       OPERANDS

16812 49 01422 J4833
16824 26 18009 00099 11920        TF     SINTH,99*
16836 16 00469 J6871 11930        FM     PX2,PX2T*
16848 26 01260 14699
16860 49 01262 J7969
16872 26 18039 00099 11940        TF     FAC,99*
16884 16 00469 J6919 11950        FM     PY2,PY2T*
16896 26 01260 14719
16908 49 01262 J7989
16920 16 00469 J6955 11960        FA     FAC,99*
16932 16 00445 J8039
16944 49 00422 -0099
16956 16 00469 J6991 11970        FD     FAC,SAVE*
16968 26 01260 18039
16980 49 01422 J4835
16992 26 17999 00099 11980        TF     COSTH,99*
17004 26 18019 17959 11990        TF     XTRANS,PX1T*
17016 16 00469 J7051 12000        FM     PX1,COSTH*
17028 26 01260 14689
17040 49 01262 J7999
17052 16 00469 J7087 12010        FS     XTRANS,99*
17064 16 00445 J8019
17076 49 00402 -0099
17088 16 00469 J7123 12020        FM     PY1,SINTH*
17100 26 01260 14709
17112 49 01262 J8009
17124 16 00469 J7159 12030        FA     XTRANS,99*
17136 16 00445 J8019
17148 49 00422 -0099
17160 26 18029 17979 12040        TF     YTRANS,PY1T*
17172 16 00469 J7207 12050        FM     PX1,SINTH*
17184 26 01260 14689
17196 49 01262 J8009
17208 16 00469 J7243 12060        FS     YTRANS,99*
17220 16 00445 J8029
17232 49 00402 -0099
17244 16 00469 J7279 12070        FM     PY1,COSTH*
17256 26 01260 14709
```

```
 I-ADD OP                P/L LABEL   OP      OPERANDS

17268 49 01262 J7999
17280 16 00469 J7315 12080          FS      YTRANS,99*
17292 16 00445 J8029
17304 49 00402 -0099
17316 32 08778 00000 12090          SF      LINE*
17328 32 02562 00000 12100          SF      BEGIN*
17340 49 02562 00000 12110          B       BEGIN*
17352 16 00469 J7387 12120 CIRROT   FM      A&39,SCALE,,ROTATES AND TRANSLATES CIRCLE CARDS*
17364 26 01260 13835
17376 49 01262 J8049
17388 26 13835 00099 12130          TF      A&39,99*
17400 44 17460 17460 12140          BNF     LINROT,LINROT*
17412 44 17448 13800 12150          BNF     *&36,A&4*
17424 33 13800 00000 12160          CF      A&4*
17436 49 17460 00000 12170          B       LINROT*
17448 32 13800 00000 12180          SF      A&4*
17460 44 17516 17460 12190 LINROT   BNF     NOINV,LINROT*
17472 44 17504 13825 12200          BNF     *&32,A&29*
17484 33 13825 00000 12210          CF      A&29*
17496 49 17516 00000 12220          B       *&20*
17504                    12230          DORG    *-3*
17504 32 13825 00000 12240          SF      A&29*
17516 26 14345 13815 12250 NOINV    TF      WORK,A&19*
17528 26 14833 13825 12260          TF      SAVE,A&29*
17540 16 00469 J7575 12270          FM      WORK,COSTH*
17552 26 01260 14345
17564 49 01262 J7999
17576 26 13815 00099 12280          TF      A&19,99*
17588 16 00469 J7623 12290          FM      SAVE,SINTH*
17600 26 01260 14833
17612 49 01262 J8009
17624 16 00469 J7659 12300          FS      A&19,99*
17636 16 00445 J8015
17648 49 00402 -0099
17660 16 00469 J7695 12310          FA      A&19,XTRANS*
17672 16 00445 J8015
17684 49 00422 J8019
17696 16 00469 J7751 12320          FM      WORK,SINTH*
```

```
 I-ADD OP              P/L LABEL   OP      OPERANDS

17708 26 01260 14345
17720 49 01262 J8009
17732 26 13825 00099 12330         TF      A&29,99*
17744 16 00469 J7779 12340         FM      SAVE,COSTH*
17756 26 01260 14833
17768 49 01262 J7999
17780 16 00469 J7815 12350         FA      A&29,99*
17792 16 00445 J3825
17804 49 00422 -0099
17816 16 00469 J7851 12360         FA      A&29,YTRANS*
17828 16 00445 J3825
17840 49 00422 J8029
17852 16 00469 J7887 12370         FM      SCALE,A&19*
17864 26 01260 18049
17876 49 01262 J3815
17888 26 13815 00099 12380         TF      A&19,99*
17900 16 00469 J7935 12390         FM      SCALE,A&29*
17912 26 01260 18049
17924 49 01262 J3825
17936 26 13825 00099 12400         TF      A&29,99*
17948 42 00000 00000 12410         BB       *
17950                12420         DORG    *-9*
17959     00010      12430 PX1T    DS      10*
17969     00010      12440 PX2T    DS      10*
17979     00010      12450 PY1T    DS      10*
17989     00010      12460 PY2T    DS      10*
17999     00010      12470 COSTH   DS      10*
18009     00010      12480 SINTH   DS      10*
18019     00010      12490 XTRANS  DS      10*
18029     00010      12500 YTRANS  DS      10*
18039     00010      12510 FAC     DS      10*
18049     00010      12520 SCALE   DS      10*
18059     00010      12530 TANTH1  DS      10*
18069     00010      12540 TANTH2  DS      10*
18079     00010      12550 TANDEL  DS      10*
18089     00010      12560 FSAVE   DS      10*
18099     00010      12570 FCHECK  DS      10*
18109     00010      12580 FRAPID  DC      10,5481000000*
```

```
  I-ADD OP              P/L LABEL   OP       OPERANDS
12580N481000000#                                                    -6J8100J8110-
18119    00010        12590 NINE    DC     10,5599999999#
12590N599999999#                                                    -6J8110J8120-
18129    00010        12600 NEGNIN  DC     10,-5599999999#
12600N599999998#                                                    -6J8120J8130-
18139    00010        12610 FLTONE  DC     10,5110000000#
12610N110000000#                                                    -6J8130J8140-
19797    00010        12615 F100    DC     10,5310000000,19797#
12615N310000000#                                                    -6J9790J9800-
02178                 12620         DEND   PSTART#
26181631866626181750000026012430000011186666-000143182200123 6#0-1J8140J8200-
26000980169749 1864800000#                                          0-1J8200J8224-
44182680124338 18662001004 8-125801259330124300000310124401690#0-1J8220J8280-
1301235000N0110009800K5543186720009815012350000-1618406-1236#0-1J8280J8340-
1618526-123626185551825516183 3000-81601260000-J1101260000-2#0-1J8340J8400-
220000001260461838801300121837 3000-14618600012002618466184 6#0-1J8400J8460-
210000001260471850801200261850218466330000000000111840 -0002#0-1J8460J8520-
320000000000111 526-000131000000000022185551870815012600000 #0-1J8520J8580-
1201260000-9491 40000000#                                           0-1J8580J8604-
261864700097120126 000-11301260000-51600090-0000260000000098#0-1J8600J8660-
-    M90000000#                                                     0-6J8660J8669-
-    08#                                                            0-6J8669J8672-
320123600000016 8406-1237491834000000#                              0-1J8672J8708-
-    J00001#                                                        0-6J8703J8709-
261873319492261 745000002601240000001119492-000143187940123 #0-1J8710J8770-
1601232000-049 947400000161882 0-000441884201240321882700000#0-1J8770J8830-
330124000000140123200 N0461949401100461896201200140123200 M7#0-1J8830J8890-
471959801300161 961-12402118961012321218961000N0160123200-00#0-1J8890J8950-
260124000000320123300000140123 000K947190940130013012400 0-6#0-1J8950J9010-
150009000 0J2201240196772601250000992800090012402900092012 0#0-1J9010J9070-
260124000089321 8829000002301240012402601260000911619165J9706#0-1J9070J9130-
1619139000-423 9696012602601250000002201250000912301250012 0#0-1J9130J9190-
1119165000J012 19139000-147191540120026012500113722012500009 1#0-1J9190J9250-
230125001240441 9310188294619298013003200091000002100091197 6#0-1J9250J9310-
441934618828320009100000210009119766160123200 N1250009200400#0-1J9310J9370-
431942600082120 1232000-131000820008325000910056949193700000 #0-1J9370J9430-
310123300082330 1233000004419474188273201240000002600000012 0#0-1J9426J9486-
490000000000#                                                       0-1J9486J9498-
```

```
I-ADD OP                P/L LABEL    OP        OPERANDS

32188280000016004691954126012601974749014 22-1240260124000099*0-1J9494J9554-
14012320 00N047188660110026012401977649194 5000000*          0-1J9554J9602-
44194501882832012400000016004691965716004 45-1240490042 2J9786*0-1J9598J9658-
4919450000 00*                                                0-1J9658J9670-
-     00000000*                                               0-6J9670J9678-
-     -769230769*                                             0-6J9678J9688-
-     -909090909*                                             0-6J9688J9698-
-     J111111111*                                             0-6J9698J9708-
-     J428571428*                                             0-6J9708J9718-
-     K000000000*                                             0-6J9718J9728-
-     L333333333*                                             0-6J9728J9738-
-     N110000000*                                             0-6J9738J9748-
-     N40419500*                                              0-6J9748J9757-
-     J570796327*                                             0-6J9757J9767-
-     N078539816*                                             0-6J9767J9777-
-     N115707963*                                             0-6J9777J9787-
1600524-052649004340160052 4-0570260126000000260094800445260 0*0-1-0402-0462-02259
48100000260125000000110046 9-0001260096000469460051801400490 0*0-1-0462-0522-02260
00004400558012503301250000 0049005700320125000000150077500001*0-1-0522-0582-02261
1600785-125024012520124246 0066601100460096601200260124001260*0-1-0582-0642-02262
26012600125026012500124025 0094101260220124201252140124 2000-P*0-1-0642-0702-02263
47009060130021007850124244 0075001250150077500002150124 20000-*0-1-0702-0762-02264
32012530000021012600000016 0097700-122500941012604700986014 00*0-1-0762-0822-02265
26012600125933012540000015 0125300001110125200 0-1460115801400*0-1-0822-0882-02266
44009060094132012600000025 0094001253110094100 0-0330125300-00*0-1-0882-0942-02267
26000000126049000000 0-0*0000000000000000000000000000000000000000-1-0942-0966-02268
32012430000049007620430093 0012534601138012003301260000003101*0-1-0966-1026-02269
25301254250126000569120125 2000-1430107801253490102204600870 0*0-1-1026-1086-02270
13002500964009773800956001 0044011380040148J000000002601260 0*0-1-1086-1146-02271
16974900882025009640097638 0095600100430120600401 48R999999999*0-1-1146-1206-02272
26012600120549008820000Q 0000Q00000Q00000Q00000Q00000Q00000Q*000000-1-1206-1262-02273
1600524-128249014340320124 3000001201242000N0230126001250250 0*0-1-1262-1322-02274
94100099460113801200160097 700-34430140200084150162100002120 1*0-1-1322-1382-02275
242000-132000850000021012 5201242490161001600524-14781600948-*0-1-1382-1442-02276
00993201253000001501621000 0149004580320124300000120124200 0N0*0-1-1442-1502-02277
28000910126029000910125046 0166201400250094100091430163000083*0-1-1502-1562-02278
46011380120032000840000160 097700-562201252012422601260000 90*0-1-1562-1622-02279
49010780120124200 0-1150162100000490158601500964000073800956 0*0-1-1622-1682-02280
```

```
  I-ADD OP              P/L LABEL   OP       OPERANDS

010048-00000000#000000000000000000000000000000000000000000000000-1-1682-2178-02281
36001  L600000005004900000#                                      -8-0096-0115-
3600100005003600172005003600244005003600316005003600000050#       -
000000000000102030400020406080003060902100408021610050015102006021814200# -
704112820080614223009081726300000000005060708090012141618151811242720242# -
822363520353045403632484455324946536048465462754453627180123456789123456# -
789-23456789-J3456789-JK456789-JKL56789-JKLM6789-JKLMN789-JKLMN089-JKLMN# -
M800000000049-21780P9-JKLMNOPQ#     L10038800019M90000000000M90003600000  -
```

Appendix F

COMPUTER PLOTTING PROGRAM FOR GE MARK CENTURY DIRECTOR

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Appendix F

TAPE PLOTTING ROUTINE

INTRODUCTION

This program plots numerical control paper tapes prepared for the GE Mark Century director on an IBM-1620 computer with an on-line Cal-Comp plotter. The input to this program (Fig. E-1 of Appendix E) is a numerical control paper tape as prepared by the AUTOMAP II Post Processor Program (Appendix E).

Typically, this tape would contain information for controlling the movements of a numerically controlled flame cutting machine along the perimeter of parts which have been nested on a steel plate. Thus, this program has the function of confirming the correctness of the nested parts prior to actual cutting of steel.

OPERATING INSTRUCTIONS

A. Clear Memory

1. Reset - Insert
2. Type 26 00002 00003 , R-S
3. After 5 seconds, press Instant Stop

B. Load Program

1. Push Reset
2. Place tape plotting program in Read Hopper
3. Press Load Key on Reader
4. Push Reader Start to read last two cards
5. Parity Switch and I/O Switch to Stop, O'flow to program

C. Operating Program

1. Thread N/C paper tape in paper tape reader
2. Set program switches

Prog. Sw. 1 - if ON, may enter on the typewriter coordinates for the desired starting point of the plotted figure. Up to eight significant digits plus a sign and a decimal point may be entered.

Example: If the starting point is (2,-2) key in

b2. R-S (where b is a blank)

-2. R-S

if Sw. 1 is OFF, the starting point is assumed to be (0,0).

Prog. Sw. 2 - If ON, the X and Y coordinates for each plotted point will be typed out. On circular moves, the computer will print out the coordinates of the end points of chords along the circle at 5° central angle intervals for the prescribed arc length.

Prog. Sw. 3 - If ON, a scale factor may be entered to plot a scaled figure. Again, up to 8 significant digits plus a sign and decimal point may be entered on the typewriter. The scale factor is a divisor; therefore, if for example, a 1/2 scale figure is desired, the value to be keyed in is b2.

If Sw. 3 is OFF, a full-scale figure will be plotted.

GENERAL DISCUSSION

The input to the director is a series of points, along with a code indicating whether successive points are to be joined by straight lines or circular arcs. If successive points are to be joined by straight lines (i.e., straight line interpolation between points), the director requires increments in the X and Y directions. If successive points are to be joined by circular arcs, the input information consists of the direction of travel on circle (clockwise or counter-clockwise), and the increments ΔX and ΔY between the successive points. The center of the circle is specified in the same record as ΔX and ΔY increments to the center of the circle. Circular arcs greater than 90° must be described in two steps.

In addition to tool path information, the tape contains information concerning the operation of the machine itself, such as torch ignition, dwells, etc. These are ignored by tape plotting program.

The first point is considered to be the origin of the figure, and consequently no actual movement of the pen will be made until the coordinates of the second point are calculated. With Switch 1 ON, the operator has the ability to key in on the typewriter the actual values of the coordinates of the first point. Otherwise, they will be automatically considered to be zero.

A circular move consists of straight line increments (chords) which correspond to a central angle of five degrees. Therefore, the initial and terminal points must be at least five central degrees apart.

The input to the main program from the conversion (CONV) subroutine consists of the following quantities:

N ΔX ΔY ΔJ ΔK

N = Code number to indicate whether the next point is to be joined by a straight line or by an arc of a circle, and will also indicate direction on circle (i.e., counter-clockwise or clockwise.

N = 1 Straight line interpolation

N = 2 Circular interpolation clockwise

N = 3 Circular interpolation counter-clockwise

ΔX ΔY = Delta-X and Delta-Y increments having both magnitude and direction

ΔJ ΔK = Delta-X and Delta-Y increments in the direction of the center of the circle when code calls for circular interpolation.

The function of the PLOT Subroutine is described on Page F-29.

SUBROUTINE FUNCTIONS

The Tape Plotting Program has been written in the FORTRAN language. This program requires the addition of two subroutines to the FORTRAN Library subroutine deck. These subroutines are called CONV and PLOT. The CONV (Conversion) subroutine has the function of converting the non-standard format of the N/C tape into a format acceptable to the FORTRAN program. The flow chart and program listing for this subroutine is contained in this Appendix, starting on Page F-36.

The PLOT subroutine has the function of doing the plotting based upon points as calculated by the mainline program. Thus, the normal sequence of events is to (1) initialize the program, (2) go to the CONV subroutine to read the N/C paper tape and convert the format of the data, (3) return to the mainline program to calculate the point to be plotted, (4) go to the PLOT subroutine to plot the calculated point, (5) return to mainline program, (6) go to CONV subroutine to read next block of information, etc.

MATHEMATICAL FORMULAE USED

For Straight Lines (Fig. F-1)

$$XB = X + X$$
$$YB = Y + Y$$



Fig. F-1

For Arcs of Circles (Figs. F-2a and F-2b)

When $\Delta X = 0$

If ΔY (+) $\longrightarrow \hat{\alpha} = 90^{\circ}$

If ΔY (-) $\longrightarrow \hat{\alpha} = 270^{\circ}$

Otherwise

$$\text{TAN}\,\hat{\alpha} = \Delta Y / \Delta X$$
$$\hat{\alpha} = \text{ARCTAN}\ \Delta X / \Delta Y$$

Also

$$R = \sqrt{\overline{\Delta J}^2 + \overline{\Delta K}^2}$$

$$AD = \sqrt{\overline{\Delta X}^2 + \overline{\Delta Y}^2}\ /2$$

$$CD = \sqrt{\overline{R}^2 - \overline{AD}^2}$$

$$\text{TAN}\ \hat{\beta} = \overline{CD} / \overline{AD}$$

$$\hat{\beta} = \text{ARCTAN}\ \overline{CD} / \overline{AD}$$

For N=3 (Counter-clockwise) $\hat{\varepsilon} = \hat{\alpha} - \hat{\beta}$

N=2 (Clockwise) $\hat{\varepsilon} = \hat{\alpha} \cdot \hat{\beta}$

In either case

$$XC = XA + R.\ COS\ \hat{\varepsilon}$$
$$YC = YA + R.\ SIN\ \hat{\varepsilon}$$
$$\hat{\gamma} = \pi - 2.\hat{\beta}$$

When XA = XC

If YA > YC $\longrightarrow \hat{\alpha} = 90^{o}$

If YA < YC $\longrightarrow \hat{\alpha} = 270^{o}$

Otherwise

$$TAN\ \hat{\alpha} = (YA - YC)/(XA - XC)$$
$$\hat{\alpha} = ARCTAN\ \hat{\alpha}$$

then,

For N=2: (Clockwise)(Fig. F-2a

First move is

$$XE = XC + R.COS\ (\hat{\alpha} - 5^{o})$$
$$YE = YC + R.SIN\ (\hat{\alpha} - 5^{o})$$

in increments of 5^{o}

Second move

$$XF = XC + R.COS\ (\hat{\alpha} - 10^{o})$$
$$YF = YC + R.SIN\ (\hat{\alpha} - 10^{o})$$

⋮ ⋮

Last move

$$XB = XC + R.COS\ (\hat{\alpha} - \hat{\gamma})$$
$$YB = YC + R.SIN\ (\hat{\alpha} - \hat{\gamma})$$

and, For N=3: (Counter-clockwise) (Fig. F-2b)

The first move is

$$XE = XC + R.COS\left(\hat{\varepsilon} + 5^{o}\right)$$
$$YE = YC + R.SIN\left(\hat{\varepsilon} + 5^{o}\right)$$

in increments of 5^{o}

Second move

$$XF = XC + R.COS\left(\hat{\varepsilon} + 10^{o}\right)$$
$$YF = YC + R.SIN\left(\hat{\varepsilon} + 10^{o}\right)$$

⋮ ⋮

Last move

$$XB = XC + R.COS\left(\hat{\varepsilon} + \hat{\delta}\right)$$
$$YB = YC + R.SIN\left(\hat{\varepsilon} + \hat{\delta}\right)$$

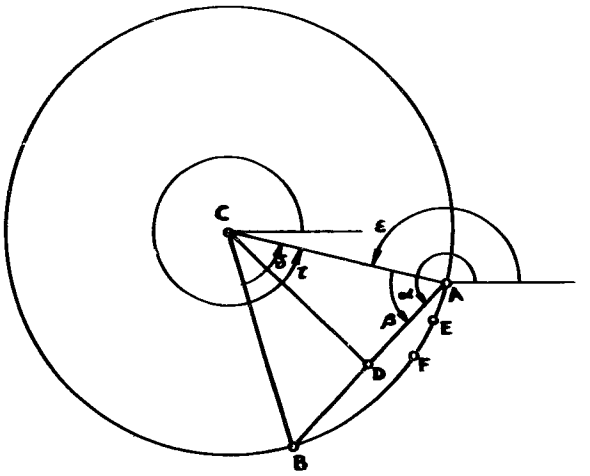


Fig. F-2a N = 2 clockwise

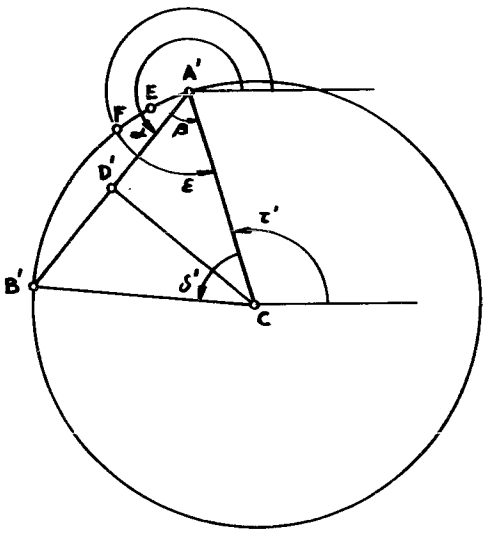
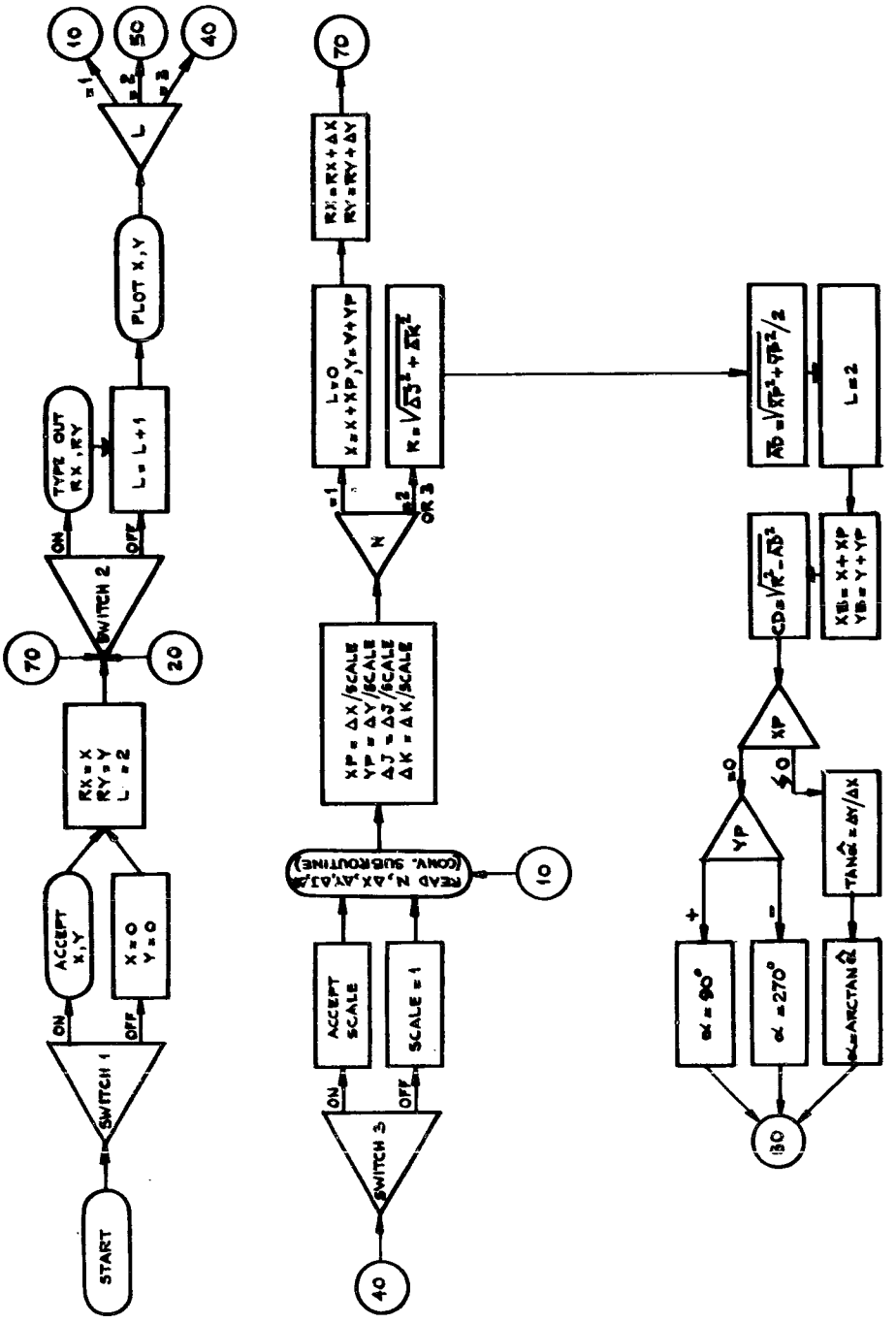
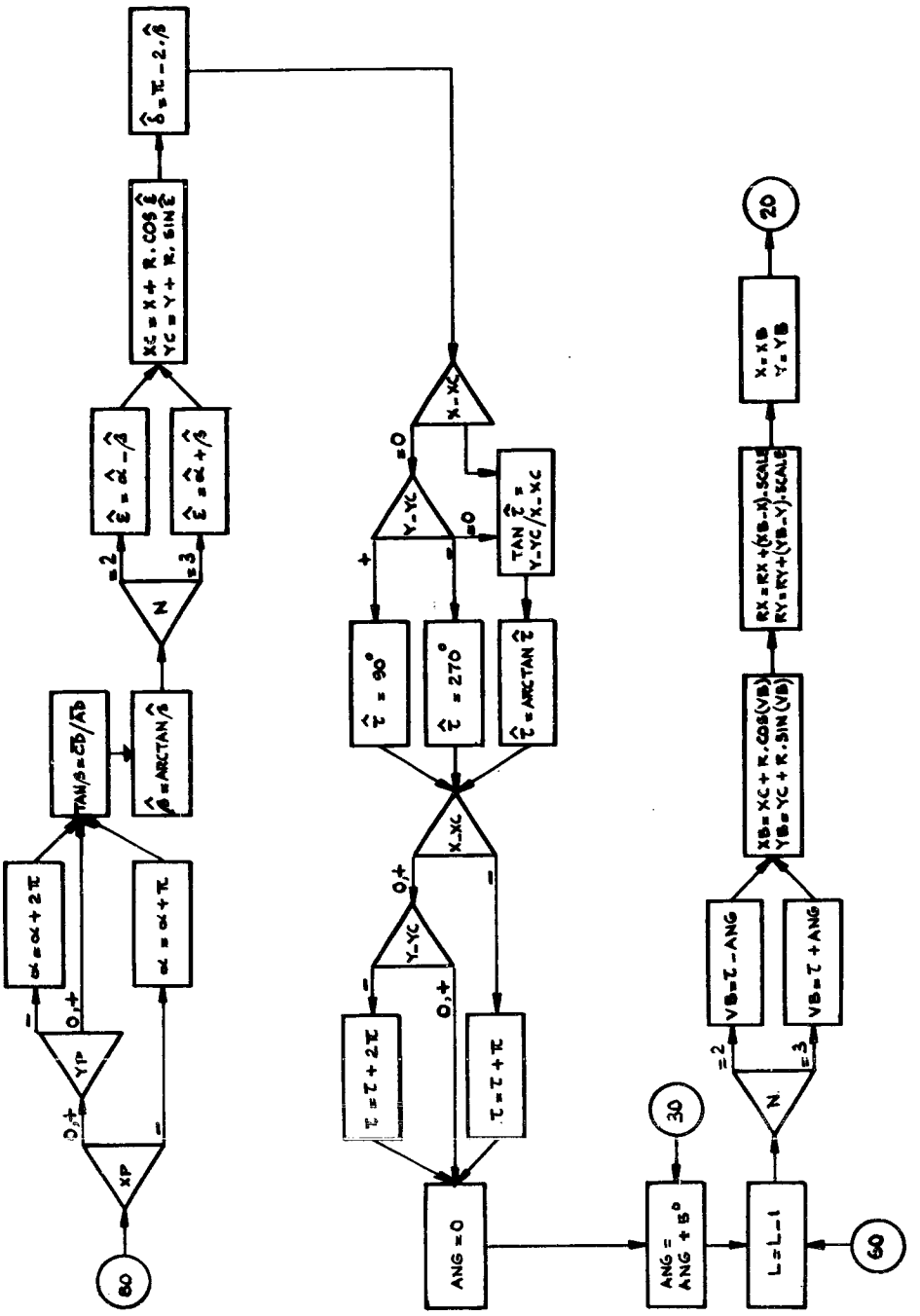
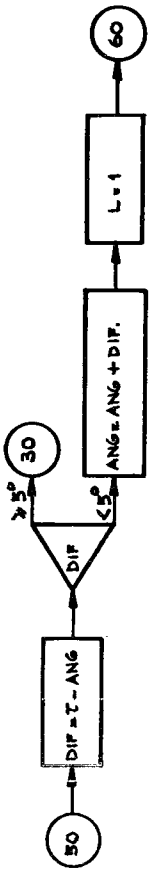


Fig. F-2b N = 3 Counter-clockwise

FLOW CHART OF THE MAIN LINE PROGRAM (FORTRAN)




δ̂ = π − 2.β̂
XC = X + R.COS ε̂
YC = Y + R.SIN ε̂
ε̂ = α̂ − β̂
ε̂ = α̂ + β̂
=2
=3
N
TAN β = ΔY/ΔX
β̂ = ARCTAN β̂
α = α + 2π
α = α + π
Y?P
X?P
0,+
−
80
X−XC
Y−YC
=0
+
−
τ̂ = 90°
τ̂ = 270°
τ̂ = ARCTAN τ̂
TAN τ̂ = Y−YC/X−XC
0,+
−
τ = τ + 2π
τ = τ + π
ANG = 0
30
ANG = ANG + 5°
L = L − 1
60
=2
=3
N
VB = τ − ANG
VB = τ + ANG
XB = XC + R.COS(VB)
YB = YC + R.SIN(VB)
RX = RX + (XB − X).SCALE
RY = RY + (YB − Y).SCALE
X = XB
Y = YB
20


60
L = 1
ANG = ANG + DIF.
30
≥5°
<5°
DIF
DIF = T - ANG
50

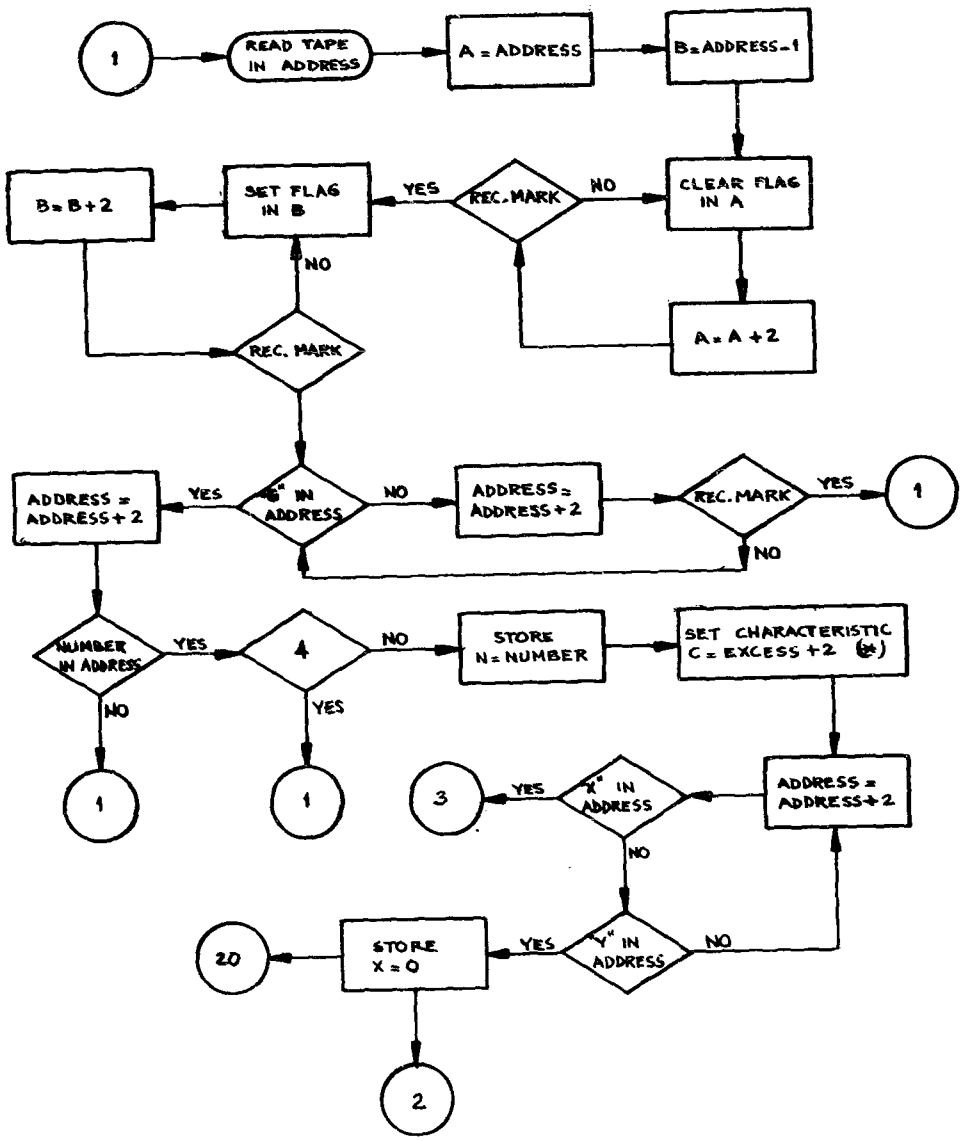
FORTRAN MAINLINE PROGRAM LISTING

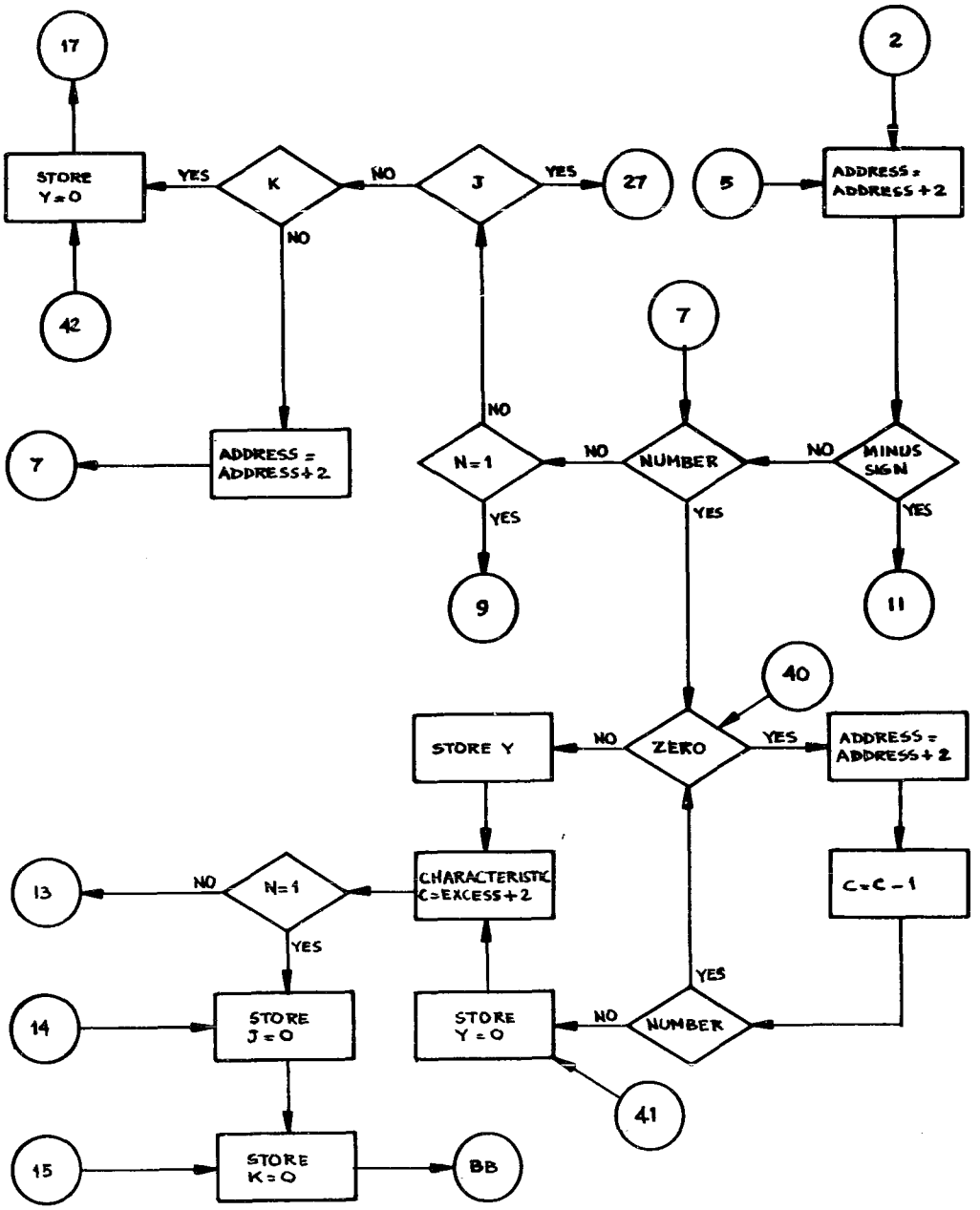
```
C    **  AIRCO TAPE PLOT   11/17/62  **
     DX=0.
     DY=0.
     DUMMY=PLOT(11111.)
     IF(SENSE SWITCH 1)61,62
61   ACCEPT 201,VALX,VALY
     GO TO 19
62   VALX=0.
     VALY=0.
19   X=VALX
     Y=VALY
     REALX=VALX
     REALY=VALY
     N=1
     DJ=0.
     DK=0.
     L=2
     GO TO 10
57   IF(SENSE SWITCH 3)54,55
54   ACCEPT 200,SCAL
     GO TO 58
55   SCAL=1.
58   DUMMY=CONV(2.)
     XP=DX/SCAL
     YP=DY/SCAL
     DJ=DJ/SCAL
     DK=DK/SCAL
     GO TO (13,14,14),N
13   X=X+XP
     Y=Y+YP
     L=0
     REALX=REALX+DX
     REALY=REALY+DY
10   IF(SENSE SWITCH 2) 16,17
16   PRINT 200,REALX,REALY
17   GO TO 320
14   L=2
     R=SQRT(DJ*DJ+DK*DK)
     XB=X+XP
     YB=Y+YP
     IF(XP)1,2,1
2    IF(YP)3,1,5
3    TANA=-9.9E48
     GO TO 4
5    TANA=9.9E48
     GO TO 4
1    TANA=YP/XP
4    V=ATAN(TANA)
```

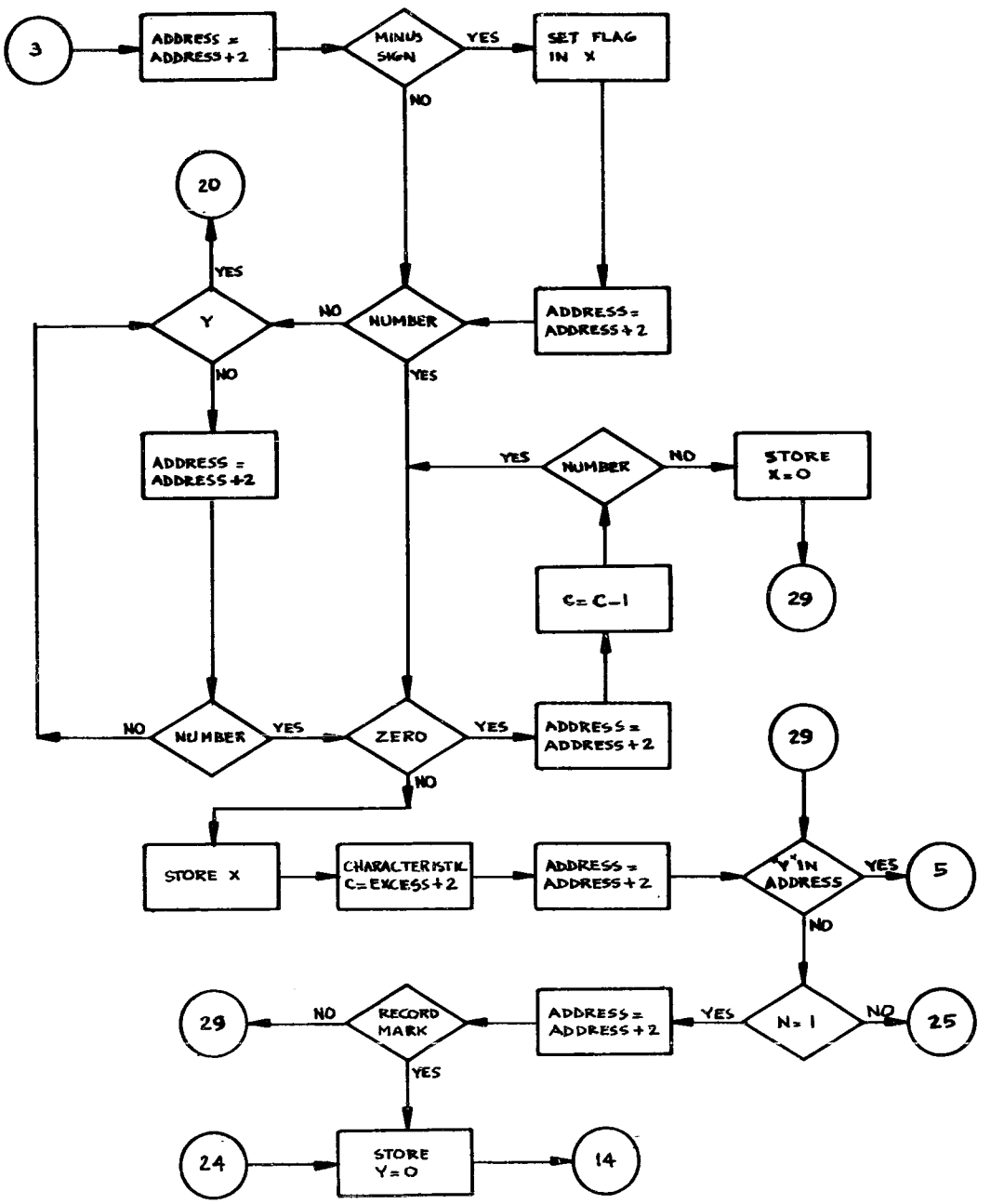
```
      IF(XP)9,8,8
8     IF(YP)6,7,7
6     V=6.28319+V
      GO TO 7
9     V=V+3.1416
7     DIST=SQRT(XP*XP+YP*YP)/2.
      ALT=SQRT(R*R-DIST*DIST)
      TANA=ALT/DIST
      VA=ATAN(TANA)
      GO TO (13,73,72),N
73    VB=V-VA
      GO TO 67
72    VB=V+VA
67    XC=X+R*COS(VB)
      YC=Y+R*SIN(VB)
      V=3.14159-2.*VA
      IF(X-XC)20,21,20
21    IF(Y-YC)22,20,24
22    VA=-1.5708
      GO TO 25
24    VA=1.5708
      GO TO 25
20    TANA=(Y-YC)/(X-XC)
      VA=ATAN(TANA)
25    IF(X-XC)27,23,23
23    IF(Y-YC)53,26,26
53    VA=6.28319+VA
      GO TO 26
27    VA=3.14159+VA
26    ANG=0.
34    ANG=ANG+.08727
44    L=L-1
      GO TO (13,37,45),N
37    VB=VA-ANG
      GO TO 36
45    VB=VA+ANG
36    XB=XC+R*COS(VB)
      YB=YC+R*SIN(VB)
      REALX=REALX+(XB-X)*SCAL
      REALY=REALY+(YB-Y)*SCAL
      X=XB
      Y=YB
      GO TO 10
30    DIF=V-ANG
      IF(DIF-.08727)47,34,34
47    ANG=ANG+DIF
      L=1
      GO TO 44
```

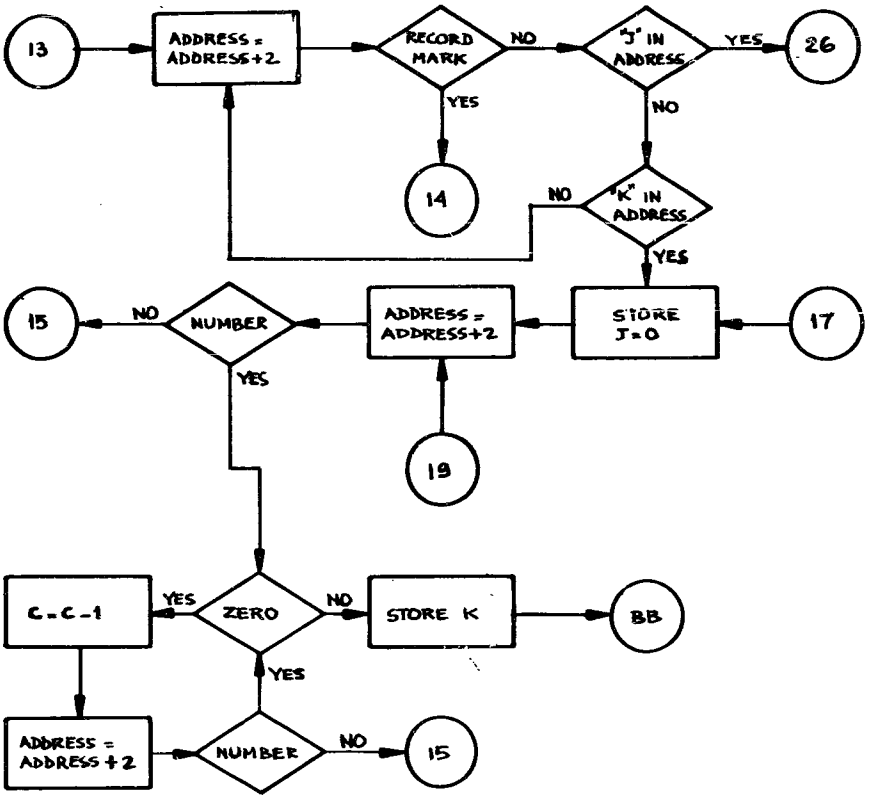
```
320 L=L+1
    X=X
    DUMMY=PLOT(Y)
110 GO TO (58,30,57),L
200 FORMAT(2F10.4)
201 FORMAT(F10.4/F10.4)
    END
```

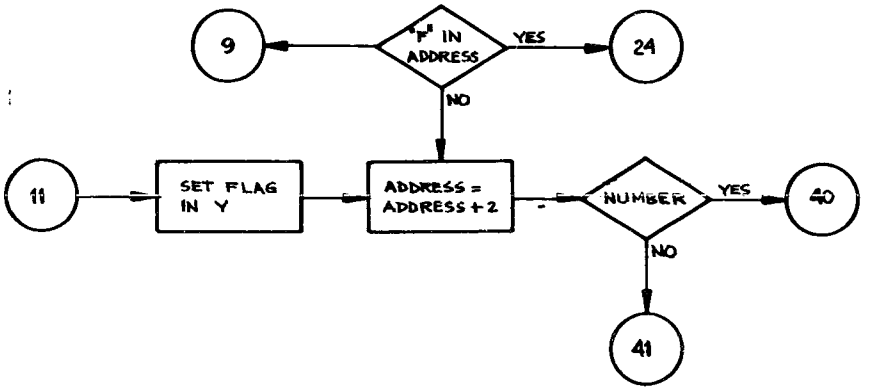
FLOW CHART OF CONVERSION (CONV) SUBROUTINE

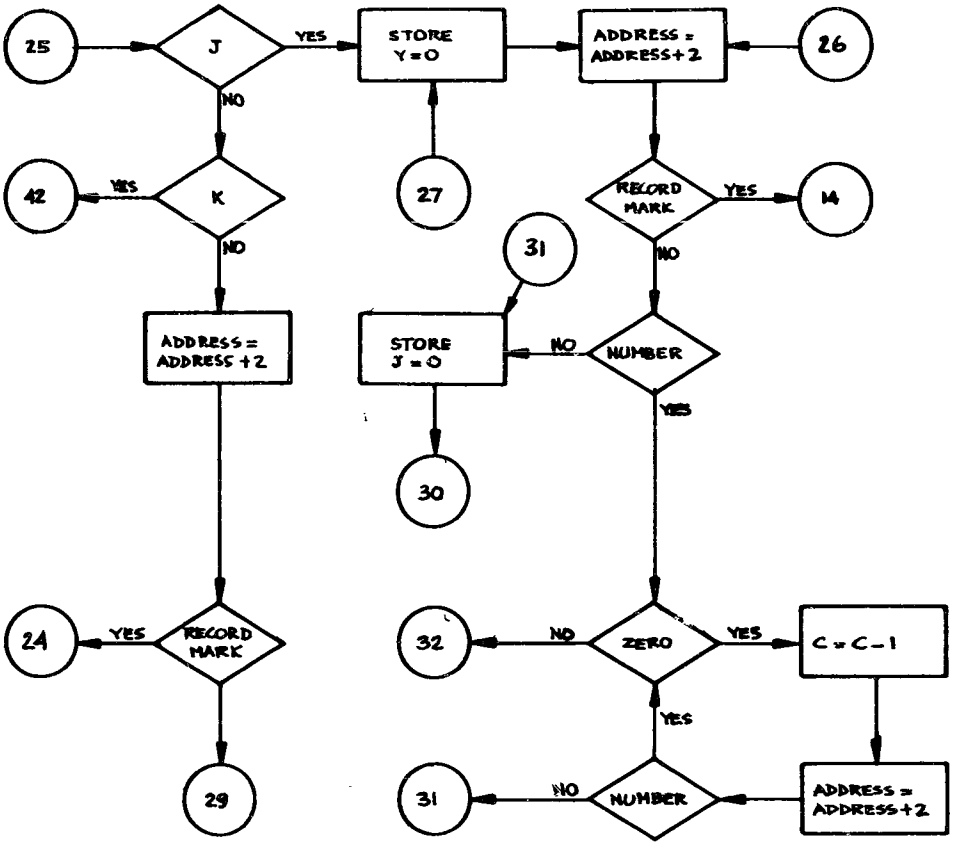


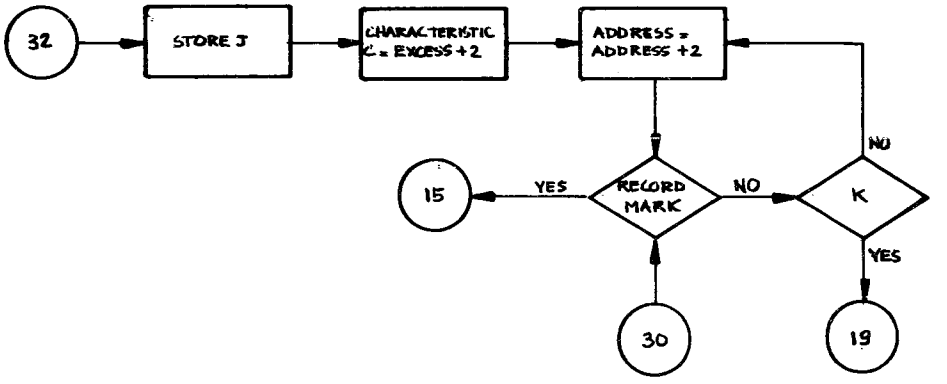

17
STORE Y=0
YES
K
NO
J
YES
27
NO
42
2
5
ADDRESS = ADDRESS+2
7
7
ADDRESS = ADDRESS+2
NO
N=1
NO
NUMBER
NO
MINUS SIGN
YES
YES
YES
9
11
40
STORE Y
NO
ZERO
YES
ADDRESS = ADDRESS+2
13
NO
N=1
CHARACTERISTIC C=EXCESS+2
C=C-1
YES
YES
14
STORE J=0
STORE Y=0
NO
NUMBER
41
15
STORE K=0
BB


3
ADDRESS = ADDRESS+2
MINUS SIGN
YES
SET FLAG IN X
NO
20
YES
Y
NO
NUMBER
ADDRESS = ADDRESS+2
NO
YES
ADDRESS = ADDRESS+2
YES
NUMBER
NO
STORE X=0
C=C-1
29
NO
NUMBER
YES
ZERO
YES
ADDRESS = ADDRESS+2
NO
29
STORE X
CHARACTERISTIC C=EXCESS+2
ADDRESS = ADDRESS+2
Y IN ADDRESS
YES
5
NO
29
NO
RECORD MARK
ADDRESS = ADDRESS+2
YES
N=1
NO
25
YES
24
STORE Y=0
14


13
ADDRESS = ADDRESS+2
RECORD MARK
NO
"J" IN ADDRESS
YES
26
YES
NO
14
NO
"K" IN ADDRESS
YES
15
NO
NUMBER
ADDRESS = ADDRESS+2
STORE J=0
17
YES
19
C=C-1
YES
ZERO
NO
STORE K
BB
YES
ADDRESS = ADDRESS+2
NUMBER
NO
15


9
"P" IN ADDRESS
YES
24
NO
11
SET FLAG IN Y
ADDRESS = ADDRESS+2
NUMBER
YES
40
NO
41


25
J
YES
STORE Y=0
ADDRESS = ADDRESS+2
26
NO
42
YES
K
27
RECORD MARK
YES
14
NO
31
ADDRESS = ADDRESS +2
STORE J=0
NO
NUMBER
YES
30
24
YES
RECORD MARK
32
NO
ZERO
YES
C = C-1
YES
29
31
NO
NUMBER
ADDRESS = ADDRESS+2


32
STORE J
CHARACTERISTIC C = EXCESS +2
ADDRESS = ADDRESS +2
NO
15
YES
RECORD MARK
NO
K
YES
30
19

PROGRAM LISTING - CONV SUBROUTINE

```
LOC  WORD #  P/L LABEL  OP       OPERANDS

1600072005303600291005[illegible]
2600045002643100000002602600114002742500000011490001200000
                        0001   *    CO NV S  CONSOLE ... 8/7 1/52
05060                                DORG   5000*
05000 37 44001 00300         BCC     RAPI   44001*
05012 J6 05042 M4001                 TFM     CHK1,44001,07*
05024 J6 05086 M4001                 TFM     CHK2,44001,07*
05036 L3 00000 00000         T       CF      ,,0*
05042    00005               CHK1    DS      5,*-5*
05048 J1 05042 -0002                 AM      CHK1,2,07*
05060 J1 05086 -0002                 AM      CHK2,2,07*
05072 MN 05036 00000                 BNR     T,,01*
05083    00005               CHK2    DS      5,**
05084 J6 05126 M4000                 TFM     CHK3,44000,07*
05096 J6 05186 M4001                 TFM     CHK4,44001,07*
05108 J6 05167 M3999                 TFM     CHK5,43999,07*
05120 L2 00000 00000         A       SF      ,,0*
05126    00005               CHK3    DS      5,*-5*
05132 J1 05126 -0002                 AM      CHK3,2,07*
05144 J1 05167 -0002                 AM      CHK5,2,07*
05156 MN 05120 00000                 BNR     A,,01*
05167    00005               CHK5    DS      5,**
05168 JC 06002 -8642                 TFM     CHK6,COMMY-7,017*
05180 J4 00000 000M7         C       CM      ,47,010*
05186    00005               CHK4    DS      5,*-5*
05192 M6 06176 01200                 BE      B,,0*
05204 J1 05186 -0002                 AM      CHK4,2,07*
05216 KO 05239 05186                 TF      *&23,CHK4,01*
05228 MN 05180 00000                 BNR     C,,01*
05240 M9 05000 00000                 B       BEG,,0*
05252 J1 05186 -0002         S       AM      CHK4,2,07*
05264 KO 05287 05186                 TF      *&23,CHK4,01*
05276 20 45009 00000                 TF      45009,,1*
05288 14 45008 000-P                 CM      45008,-7,10*
05300 M7 05000 01200                 BNE     BEG,,0*
05312 KO 05330 05186                 TF      *&18,CHK4,01*
05324 J4 00000 000P1                 CM      ,71,010*
05336 M6 05420 01200                 BE      NUMB,,0*
```

```
I-ADD OP                P/L LABEL   OP      OPERANDS

05348 KO 05366 05186            TF      *&18,CHK4,01*
05360 J4 00000 000P2            CM      ,72,010*
05372 M6 05420 01200            BE      NUMB,,0*
05384 KO 05402 05186            TF      *&18,CHK4,01*
05396 J4 00000 000P3            CM      ,73,010*
05408 M7 05000 01200            BNE     BEG,,0*
05420 KO 05443 05186    NUMB    TF      *&23,CHK4,01*
05432 2N 59629 00000            TD      N,,1*
05444 20 59628 08626            TF      N-1,ZERO3,1*
05456 J1 05186 -0002    E       AM      CHK4,2,07*
05468 KO 05491 05186            TF      *&23,CHK4,01*
05480 MN 05504 00000            BNR     D,,01*
05492 M9 05000 00000            B       BEG,,0*
05504 KO 05522 05186    D       TF      *&18,CHK4,01*
05516 J4 00000 00007            CM      ,67,010*
05528 M6 06200 01200            BE      F,,0*
05540 KO 05558 05186    OZ      TF      *&18,CHK4,01*
05552 J4 00000 00008            CM      ,68,010*
05564 M7 05456 01200            BNE     E,,0*
05576 20 59799 08633    NZ      TF      X,NINE,1*
05588 20 59797 08641            TF      X-2,ZERO8,1*
05600 J1 05186 -0002    Z       AM      CHK4,2,07*
05612 KO 05630 05186            TF      *&18,CHK4,01*
05624 J4 00000 000KU            CM      ,20,010*
05636 M7 06620 01200            BNE     G,,0*
05648 L2 08649 00000            SF      DUMMY,,0*
05660 J1 05186 -0002            AM      CHK4,2,07*
05672 KO 05695 05186            TF      *&23,CHK4,01*
05684 20 45009 00000            TF      45009,,1*
05696 I4 45008 000-P            CM      45008,-7,10*
05708 M7 05864 01200            BNE     H,,0*
05720 KO 05738 05186    L       TF      *&18,CHK4,01*
05732 J4 00000 000P0            CM      ,70,010*
05744 M7 05972 01200            BNE     K1,,0*
05756 J2 08651 000-1            SM      CHAR,1,010*
05768 J1 05186 -0002    FZ      AM      CHK4,2,07*
05780 KO 05803 05186            TF      *&23,CHK4,01*
05792 20 45009 00000            TF      45009,,1*
```

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I-ADD OP                    P/L LABEL   OP      OPERANDS

05804 14 45008 000-P                    CM      45008,-7,10*
05816 M6 05720 01200                    BE      L,,0*
05828 20 59777 08641                    TF      Y-2,ZERO8,1*
05840 20 59779 08633                    TF      Y,NINE,1*
05852 M9 06104 00000                    B       N,,0*
05864 20 59777 08641        H           TF      Y-2,ZERO8,1*
05876 20 59779 08633                    TF      Y,NINE,1*
05888 14 59629 000-1        NT          CM      N,1,10*
05900 M7 06740 01200                    BNE     P,,0*
05912 20 59607 08641        CZ          TF      J-2,ZERO8,1*
05924 20 59609 08633                    TF      J,NINE,1*
05936 20 59597 08641        KZ          TF      K-2,ZERO8,1*
05948 20 59599 08633                    TF      K,NINE,1*
05960 M9 08384 00000                    B       GOK,,0*
05972 J0 06002 -8642        KT          TFM     CHK6,DUMMY-7,017*
05984 K0 06007 05186        R           TF      *E23,CHK4,01*
05996 KN 00000 00000
06002    00005              CHK6        DS      5,*-5*
06008 J1 05186 -0002                    AM      CHK4,2,07*
06020 K0 06043 05186                    TF      *E23,CHK4,01*
06032 20 45009 00000                    TF      45009,,1*
06044 14 45008 000-P                    CM      45008,-7,10*
06056 M6 06152 01200                    BE      Q,,0*
06068 L2 08642 00000                    SF      DUMMY-7,,0*
06080 20 59777 08649                    TF      Y-2,DUMMY,1*
06092 20 59779 08651                    TF      Y,CHAR,1*
06104 L3 08649 00000        M           CF      DUMMY,,0*
06116 K0 08649 08641                    TF      DUMMY,ZERO8,01*
06128 J6 08651 000-2                    TFM     CHAR,2,010*
06140 M9 05888 00000                    B       NT,,0*
06152 J1 06002 -0001        Q           AM      CHK6,1,07*
06164 M9 05984 00000                    B       R,,0*
06176 16 45008 00-00        B           TFM     45008,,9*
06188 M9 05252 00000                    B       S,,0*
06200 J1 05186 -0002        F           AM      CHK4,2,07*
06212 K0 06230 05186                    TF      *E18,CHK4,01*
06224 J4 00000 000K0                    CM      ,20,010*
06236 M7 07052 01200                    BNE     U,,0*
```

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I-ADD OP                P/L LABEL   OP      OPERANDS

06248 L2 08649 00000            SF      DUMMY,,0*
06260 J1 05186 -0002            AM      CHK4,2,07*
06272 K0 06295 05186            TF      *&23,CHK4,01*
06284 20 45009 00000            TF      45009,,1*
06296 14 45008 000-P            CM      45008,-7,10*
06308 M7 07208 01200            BNE     V,,0*
06320 K0 06338 05186        YT  TF      *&18,CHK4,01*
06332 J4 00000 000P0            CM      ,70,010*
06344 M7 07232 01200            BNE     W,,0*
06356 J2 08651 000-1            SM      CHAR,1,010*
06368 J1 05186 -0002            AM      CHK4,2,07*
06380 K0 06403 05186        XT  TF      *&23,CHK4,01*
06392 20 45009 00000            TF      45009,,1*
06404 14 45008 000-P            CM      45008,-7,10*
06416 M6 06320 01200            BE      YT,,0*
06428 20 59797 08641            TF      X-2,ZERO8,1*
06440 20 59799 08633            TF      X,NINE,1*
06452 L3 08649 00000        RZ  CF      DUMMY,,0*
06464 K0 08649 08641            TF      DUMMY,ZERO8,01*
06476 J6 08651 000-2            TFM     CHAR,2,010*
06488 K0 06506 05186        BZ  TF      *&18,CHK4,01*
06500 J4 00000 00008            CM      ,68,010*
06512 M6 05600 01200            BE      Z,,0*
06524 14 59629 000-1            CM      N,1,10*
06536 M7 07412 01200            BNE     AZ,,0*
06548 J1 05186 -0002            AM      CHK4,2,07*
06560 K0 06583 05186            TF      *&23,CHK4,01*
06572 MN 06488 00000            BNR     BZ,,01*
06584 20 59777 08641        EZ  TF      Y-2,ZERO8,1*
06596 20 59779 08633            TF      Y,NINE,1*
06608 M9 05912 00000            B       CZ,,0*
06620 K0 06643 05186        G   TF      *&23,CHK4,01*
06632 20 45009 00000            TF      45009,,1*
06644 14 45008 000-P            CM      45008,-7,10*
06656 M6 05720 01200            BE      L,,0*
06668 14 59629 000-1            CM      N,1,10*
06680 M7 08060 01200            BNE     DZ,,0*
06692 K0 06710 05186            TF      *&18,CHK4,01*
```

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1-ADD OP                    P/L LABEL   OP      OPERANDS

06704 J4 00000 000M6                    CM      ,46,010*
06716 M6 06584 01200                    BE      EZ,,0*
06728 M9 05768 00000                    B       FZ,,0*
06740 K0 06763 05186        P           TF      *&23,CHK4,01*
06752 MN 06776 00000                    BNR     GZ,,01*
06764 M9 05912 00000                    B       CZ,,0*
06776 K0 06794 05186        GZ          TF      *&18,CHK4,01*
06788 J4 00000 000N1                    CM      ,51,010*
06800 M6 07472 01200                    BE      TZ,,0*
06812 K0 06830 05186                    TF      *&18,CHK4,01*
06824 J4 00000 000N2                    CM      ,52,010*
06836 M7 08216 01200        CX          BNE     JZ,,0*
06848 20 59607 08641                    TF      J-2,ZERO8,1*
06860 20 59609 08633                    TF      J,NINE,1*
06872 J1 05186 -0002        WZ          AM      CHK4,2,07*
06884 K0 06907 05186                    TF      *&23,CHK4,01*
06896 20 45009 00000                    TF      45009,,1*
06908 14 45008 000-P                    CM      45008,-7,10*
06920 M7 05936 01200                    BNE     KZ,,0*
06932 K0 06950 05186        MZ          TF      *&18,CHK4,01*
06944 J4 00000 000P0                    CM      ,70,010*
06956 M7 08240 01200                    BNE     LZ,,0*
06968 J2 08651 000-1                    SM      CHAR,1,010*
06980 J1 05186 000-2                    AM      CHK4,2,010*
06992 K0 07015 05186                    TF      *&23,CHK4,01*
07004 20 45009 00000                    TF      45009,,1*
07016 14 45008 000-P                    CM      45008,-7,10*
07028 M6 06932 01200                    BE      MZ,,0*
07040 M9 05936 00000                    B       KZ,,0*
07052 K0 07075 05186        U           TF      *&23,CHK4,01*
07064 20 45009 00000                    TF      45009,,1*
07076 14 45008 000-P                    CM      45008,-7,10*
07088 M6 06320 01200                    BE      YT,,0*
07100 K0 07118 05186                    TF      *&18,CHK4,01*
07112 J4 00000 00008                    CM      ,68,010*
07124 M6 05576 01200                    BE      NZ,,0*
07136 J1 05186 -0002                    AM      CHK4,2,07*
07148 K0 07171 05186                    TF      *&23,CHK4,01*
```

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I-ADD OP              P/L LABEL   OP      OPERANDS

07160 20 45009 00000              TF      45009,,1*
07172 14 45008 000-P              CM      45008,-7,10*
07184 M6 06320 01200              BE      YT,,0*
07196 M9 05540 00000              B       OZ,,0*
07208 L3 08649 00000        V     CF      DUMMY,,0*
07220 M9 05540 00000              B       OZ,,0*
07232 J0 06002 -8642        W     TFM     CHK6,DUMMY-7,017*
07244 K0 07279 05186        QZ    TF      *&35,CHK4,01*
07256 K0 07274 06002              TF      *&18,CHK6,01*
07268 KN 00000 00000              TD      ,,01*
07280 J1 05186 -0002              AM      CHK4,2,07*
07292 K0 07315 05186              TF      *&23,CHK4,01*
07304 20 45009 00000              TF      45009,,1*
07316 14 45008 000-P              CM      45008,-7,10*
07328 M7 07364 01200              BNE     PZ,,0*
07340 J1 06002 -0001              AM      CHK6,1,07*
07352 M9 07244 00000              B       QZ,,0*
07364 L2 08642 00000        PZ    SF      DUMMY-7,,0*
07376 20 59797 08649              TF      X-2,DUMMY,1*
07388 20 59799 08651              TF      X,CHAR,1*
07400 M9 06452 00000              B       RZ,,0*
07412 K0 07430 05186        AZ    TF      *&18,CHK4,01*
07424 J4 00000 000N1              CM      ,51,010*
07436 M7 07940 01200              BNE     SZ,,0*
07448 20 59777 08641        DX    TF      Y-2,ZERO8,1*
07460 20 59779 08633              TF      Y,NINE,1*
07472 J1 05186 -0002        TZ    AM      CHK4,2,07*
07484 K0 07507 05186              TF      *&23,CHK4,01*
07496 MN 07520 00000              BNR     UZ,,01*
07508 M9 05912 00000              B       CZ,,0*
07520 K0 07543 05186        UZ    TF      *&23,CHK4,01*
07532 20 45009 00000              TF      45009,,1*
07544 14 45008 000-P              CM      45008,-7,10*
07556 M6 07676 01200              BE      VZ,,0*
07568 20 59607 08641              TF      J-2,ZERO8,1*
07580 20 59609 08633              TF      J,NINE,1*
07592 K0 07610 05186        XZ    TF      *&18,CHK4,01*
07604 J4 00000 000N2              CM      ,52,010*
```

```
I-ADD OP                P/L LABEL   OP      OPERANDS

07616 M6 06872 01200                GE      WZ,,0*
07628 J1 05186 -0002                AM      CHK4,2,07*
07640 K0 07663 05186                TF      *&23,CHK4,01*
07652 MN 07592 00000                BNR     XZ,,01*
07664 M9 05936 00000                B       KZ,,0*
07676 K0 07694 05186        VZ      TF      *&18,CHK4,01*
07688 J4 00000 000P0                CM      ,70,010*
07700 M7 08444 01200                BNE     YZ,,0*
07712 J2 08651 000-1                SM      CHAR,1,010*
07724 J1 05186 -0002                AM      CHK4,2,07*
07736 K0 07759 05186                TF      *&23,CHK4,01*
07748 20 45009 00000                TF      45009,,1*
07760 14 45008 000-P                CM      45008,-7,10*
07772 M6 07676 01200                GE      VZ,,0*
07784 20 59607 08641                TF      J-2,ZERO8,1*
07796 20 59609 08633                TF      J,NINE,1*
07808 L3 08649 00000        LX      CF      DUMMY,,0*
07820 K0 08649 08641                TF      DUMMY,ZERO8,01*
07832 J6 08651 000-2                TFM     CHAR,2,010*
07844 K0 07867 05186                IF      *&23,CHK4,01*
07856 MN 07880 00000        AX      BNR     ZZ,,01*
07868 M9 05936 00000                B       KZ,,0*
07880 K0 07898 05186        ZZ      TF      *&18,CHK4,01*
07892 J4 00000 000N2                CM      ,52,010*
07904 M6 06872 01200                GE      WZ,,0*
07916 J1 05186 -0002                AM      CHK4,2,07*
07928 M9 07856 00000                B       AX,,0*
07940 K0 07958 05186        SZ      TF      *&18,CHK4,01*
07952 J4 00000 000N2                CM      ,52,010*
07964 M7 08012 01200                BNE     BX,,0*
07976 20 59777 08641                TF      Y-2,ZERO8,1*
07988 20 59779 08633                TF      Y,NINE,1*
08000 49 06836 00000                B       CX,0*
08012 J1 05186 -0002        BX      AM      CHK4,2,07*
08024 K0 08047 05186                TF      *&23,CHK4,01*
08036 MN 06488 00000                BNR     BZ,,01*
08048 M9 06584 00000                B       EZ,,0*
08060 K0 08078 05186        DZ      TF      *&18,CHK4,01*
```

```
I-ADD OP                    P/L LABEL   OP      OPERANDS

08072 J4 00000 000N1                    CM      ,51,010$
08084 M6 07448 01200                    BE      DX,,0$
08096 KO 08114 05186                    TF      *610,CHK4,01$
08108 J4 00000 000N2                    CM      ,52,010$
08120 M7 08168 01200                    BNE     EX,,0$
08132 20 59777 08641                    TF      Y-2,ZERO8,1$
08144 20 59779 08633                    TF      Y,NINE,1$
08156 M9 06836 00000                    B       CX,,0$
08168 J1 05186 -0002            EX      AM      CHK4,2,07$
08180 KO 08205 05186                    TF      *623,CHK4,01$
08192 MN 06620 00000                    BNR     G,,01$
08204 M9 06584 00000                    B       EZ,,0$
08216 J1 05186 -0002            JZ      AM      CHK4,2,07$
08228 M9 06740 00000                    B       P,,0$
08240 JO 06002 -8642            LZ      TFM     CHK6,DUMMY-7,017$
08252 KO 08282 06002            HX      TF      *630,CHK6,01$
08264 KO 08287 05186                    TF      *623,CHK4,01$
08276 KN 00000 00000                    TD      ,,01$
08288 J1 05186 -0002                    AM      CHK4,2,07$
08300 KO 08325 05186                    TF      *623,CHK4,01$
08312 20 45009 00000                    TF      45009,,1$
08324 14 45008 000-P                    CM      45008,-7,10$
08336 M6 08420 01200                    BE      GX,,0$
08348 L2 08642 00000                    SF      DUMMY-7,,0$
08360 20 59597 08649                    TF      K-2,DUMMY,1$
08372 20 59599 08651                    TF      K,CHAR,1$
08384 KO 08649 08641            GOK     TF      DUMMY,ZERO8,01$
08396 J6 08651 000-2                    TFM     CHAR,2,010$
08408 42 00000 00000                    BB      $
08420 J1 06002 -0001            GX      AM      CHK6,1,07$
08432 M9 08252 00000                    B       HX,,0$
08444 JO 06002 -8642            YZ      TFM     CHK6,DUMMY-7,017$
08456 KO 08486 06002            KX      TF      *630,CHK6,01$
08468 KO 08491 05186                    TF      *623,CHK4,01$
08480 KN 00000 00000                    TD      ,,01$
08492 J1 05186 -0002                    AM      CHK4,2,07$
08504 KO 08527 05186                    TF      *623,CHK4,01$
08516 20 45009 00000                    TF      45009,,1$
```

```
I-ADD OP              P/L LABEL   OP      OPERANDS

08528 I4 45008 000-P          CM    45008,-7,10*
08540 M7 08576 01200          BNE   JX,,0*
08552 J1 06002 -0001          AM    CHK6,1,07*
08564 M9 08456 00000          B     KX,,0*
08576 L2 08642 00000    JX    SF    DUMMY-7,,0*
08588 20 59607 08649          TF    J-2,DUMMY,1*
08600 20 59609 08651          TF    J,CHAR,1*
08612 M9 07808 00000          B     LX,,0*
08626    00003          ZERO3 DC    3,000*
00000-00*                                                  -6-8624-8627-
08631    00005          ZERO5 DC    5,00000*
00000-0000*                                                -6-8627-8632-
08633    00002          NINE  DC    2,-99*
00000RR*                                                   -6-8632-8634-
08641    00008          ZERO8 DC    8,00000000*
00000-0000000*                                             -6-8634-8642-
08649    00008          DUMMY DC    8,00000000*
00000-0000000*                                             -6-8642-8650-
08651    00002          CHAR  DC    2,02*
00000-2*                                                   -6-8650-8652-
59799    00010          X     DS    10,59799*
59779    00010          Y     DS    10,59779*
59609    00010          J     DS    10,59609*
59599    00010          K     DS    10,59599*
59629    00004          N     DS    4,59629*
08652    00001          REC   DC    1,1*
00000*                                                     -6-8652-8653-
05000                         DEND  5000*
00000  L60000005004900000*                                 -8-0096-0115-
3600100005003600172005003600244005003600316005003600000005:00                -
000000000001020304000204060800030609021004080216100500151020060218142004* -
704112820080614223009081726300000000050607080900121416181518112427202424* -
822363520353045403632484455324946536048465462754453627180123456789123456* -
789-23456789-J3456789-JK456789-JKL56789-JKLM6789-JKLMN789-JKLMN089-JKLMN* -
M8000000000049-50000P9-JKLMNOPQ*     L10038800019M900000000000M90003600000  -
```

PLOT SUBROUTINE

METHOD

The plotter traces straight line increments along one of the eight directions (four axes) shown in Fig. 1. The increments are .01" in the X and Y directions, and .01414" for the inclined directions.

A punch tape instruction, 1, 2, 3, ..., 8, will move the plotter in one of eight specific directions. Instruction 0 will raise the pen, and 9 will lower the pen.

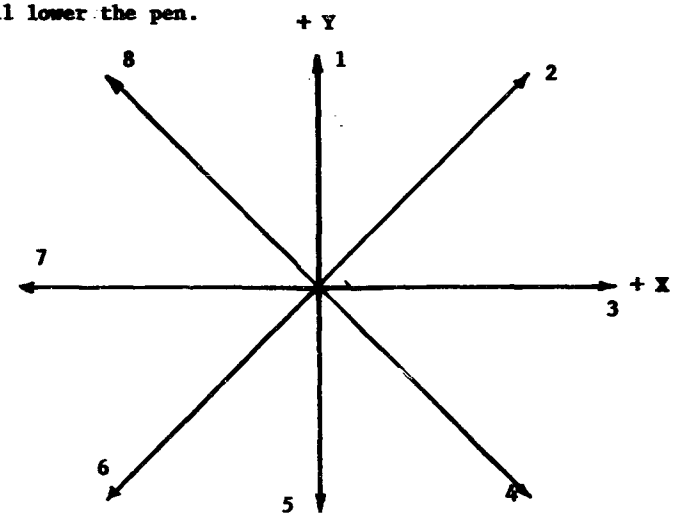


Fig. 1 Direction of Movement of Plotter

Given a particular quadrant (Fig. 2), and a specific point, the line connecting this point to the origin must fall in one of the five cases listed below:

Case 1	Point P : $\Delta Y = 0$
Case 2	Point Q : $\Delta X > \Delta Y$
Case 3	Point R : $\Delta X = \Delta Y$
Case 4	Point S : $\Delta Y > \Delta X$
Case 5	Point T : $\Delta X = 0$

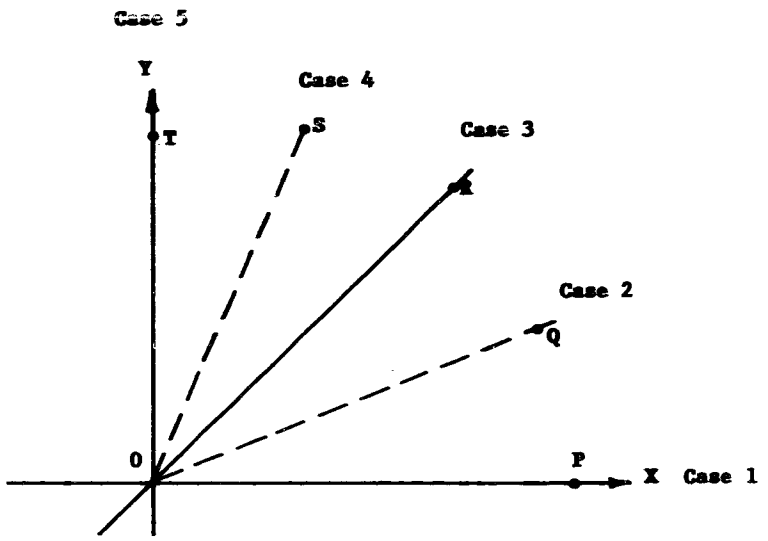


Fig. 2

After determining the case, the problem is reduced to positioning the point to one side of the bisector of the quadrant.

For Point P having a null or less than .005 increment in the Y direction, the procedure is as follows:

1. Round off the increment at the 1/100 position by adding or subtracting .005 to its value if positive or negative respectively.
2. Add this rounded value to the corresponding coordinate of Point 0 and store it as the origin to determine the increment for the next point to be joined.
3. Check for digit in the units position of the absolute value of the increment for fast one-inch moves.
4. Check for digit in the 1/10 position for fast 1/10th-inch moves.
5. Test for digit in the 1/100 position for single moves.

By subtracting one from the corresponding position after each move, the increment will be zero at the completion of the total move.

For Point R the procedure is the same as mentioned above for Point P with the difference that both increments X and Y ..., (Fig. 2) will be rounded off and added to the coordinates of Point 0 .

The method for plotting those Points Q having unequal increments in X and Y is as follows:

1. Get the ratio of the smaller to the larger increment in absolute value.
2. Round off the increments X and Y and add them to the coordinates of the Point 0 to use these new values as the origin to calculate the increments for the next point to be joined.
3. Approximate the line $\overline{OQ}$ (Fig. 3) with segments $\overline{OA}$, $\overline{AB}$, etc., in the following manner.
4. Set an XY counter equal to .005
5. Add $\overline{MN}$ (Ratio x .01") to the counter
6. Compare the counter with $\overline{AM}$ (= .01) (check for digit in the 1/100 position)
   a. If the counter is greater, it means that we are closer to the actual line going through the diagonal rather than the horizontal line

$$\overline{MN} + .005 > \overline{AM}$$

$$\therefore \overline{AM} - \overline{MN} < .005$$

(Note: The XY counter has to be reduced by $\overline{MA}$ after the diagonal move and the cycle goes back to Step 5.)

b. If the counter is less than $\overline{MA}$ the closest path is the horizontal line

$$\overline{MN} + .005 < \overline{AM}$$

$$\therefore \overline{AM} - \overline{MN} > .005$$

(Note: The cycle goes back directly to Step 5 after the horizontal move.)

An analysis of the moves from 0 to B of Fig. 3 will help to clarify the method.

1. XY counter = $\overline{MN} + .005 > \overline{AM}$
2. Move $\overline{OA}$
3. XY Counter = $\overline{MN} + .005 - \overline{AM}$
4. XY Counter = $\overline{MN} + .005 - \overline{AM} + \overline{MN}$

   $= 2\overline{MN} + .005 - \overline{AM}$
5. XY Counter = $\overline{LK} + .005 - \overline{AM} < \overline{AM}$

   $\therefore \overline{LK} + .005 < \overline{2AM}$

   $.005 < \overline{HK} - \overline{LK}$
6. Move $\overline{AB}$

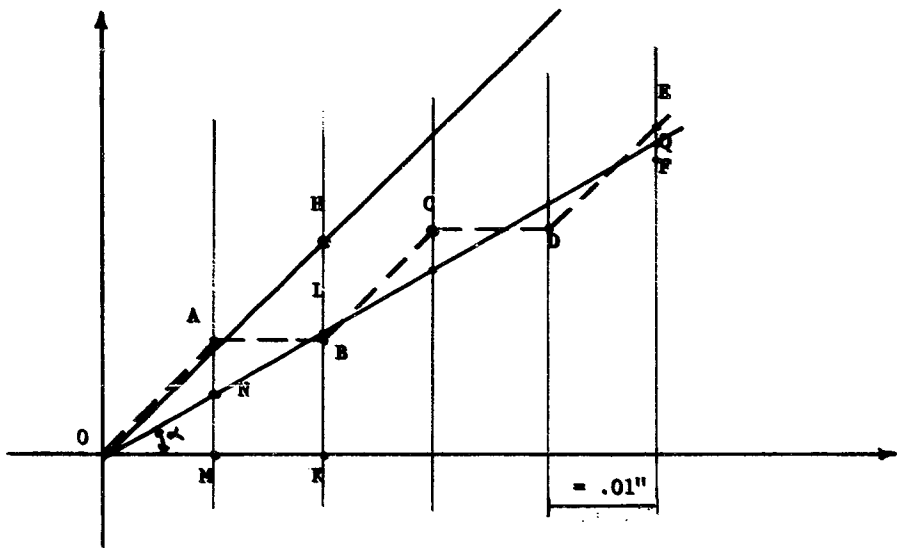


Fig. 3

USE OF THE SUBROUTINE IN A FORTRAN PROGRAM*

The calling sequence for the plot subroutine is:

```
    X = Any expression
Dummy = PLOTF (Y)
```

Where:

X = Coordinate X of the point to be plotted. This value must be on the right-hand side of the instruction preceding the plot instruction. This is to place this value in FAC (Floating Point Accumulator).

Y = Coordinate Y of the same point

Dummy = Any floating point dummy variable not used in computation

a. Dummy = PLOTF (11111.) is an instruction that must be placed at the beginning of the program. This will set the subroutine to start, put the pen down, and ready the subroutine for a set of data.

b. Dummy = PLOTF (50000.) will only put the pen down

c. Dummy = PLOTF (60000.) will put the pen up

Instructions b., and c., are complete by themselves and do not require any prior instruction.

Attention is called to the fact that the origin of the plotted figure is automatically set as the first point.

This subroutine can only handle X and Y values having up to three integers (at the moment they are stored in FAC and argument, respectively, ready to be plotted).

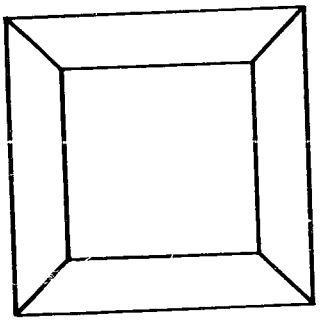
*The User should refer to the FORTRAN Manual for the procedure to incorporate this subroutine in the library subroutines deck.

```
      * * *       SAMPLE FORTRAN PROGRAM        * * *

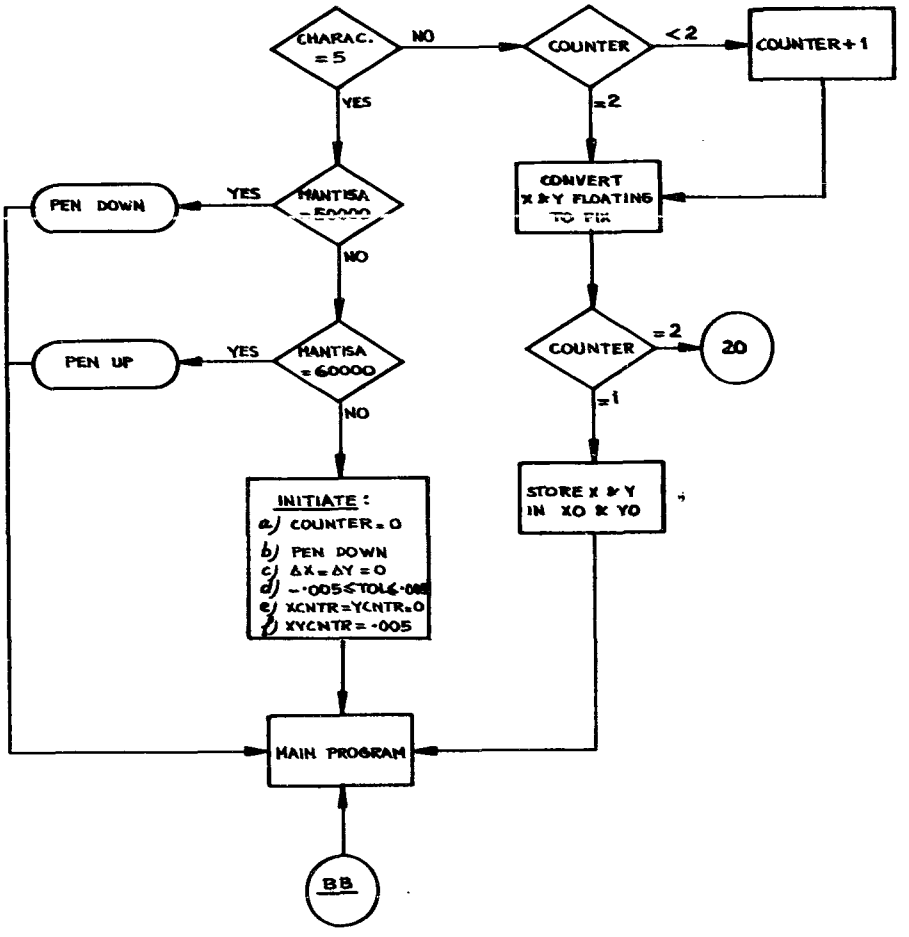
C     SAMPLE PROBLEM FOR PLOT SUBROUTINE
      JULIO=0
C     SET THE PLOT SUBROUTINE TO INITIATE
   10 DUMMY=PLOTF(11111.)
      READ 100,SCALX,SCALY
C     READ IN X AND Y COORDINATES OF THE POINT
   11 READ 100,X,Y
C     CHECK FOR PEN UP OR DOWN
      IF(X-5000.)12,13,14
C     PUT THE PEN DOWN
   13 DUMMY=PLOTF(50000.)
      GO TO 11
C     PUT THE PEN UP
   14 DUMMY=PLOTF(60000.)
      GO TO 11
   12 Y=Y*SCALY
      X=X*SCALX
      DUMMY=PLOTF(Y)
      GO TO 11
  100 FORMAT(8X,F15.8,3X,F15.8)
      END
```

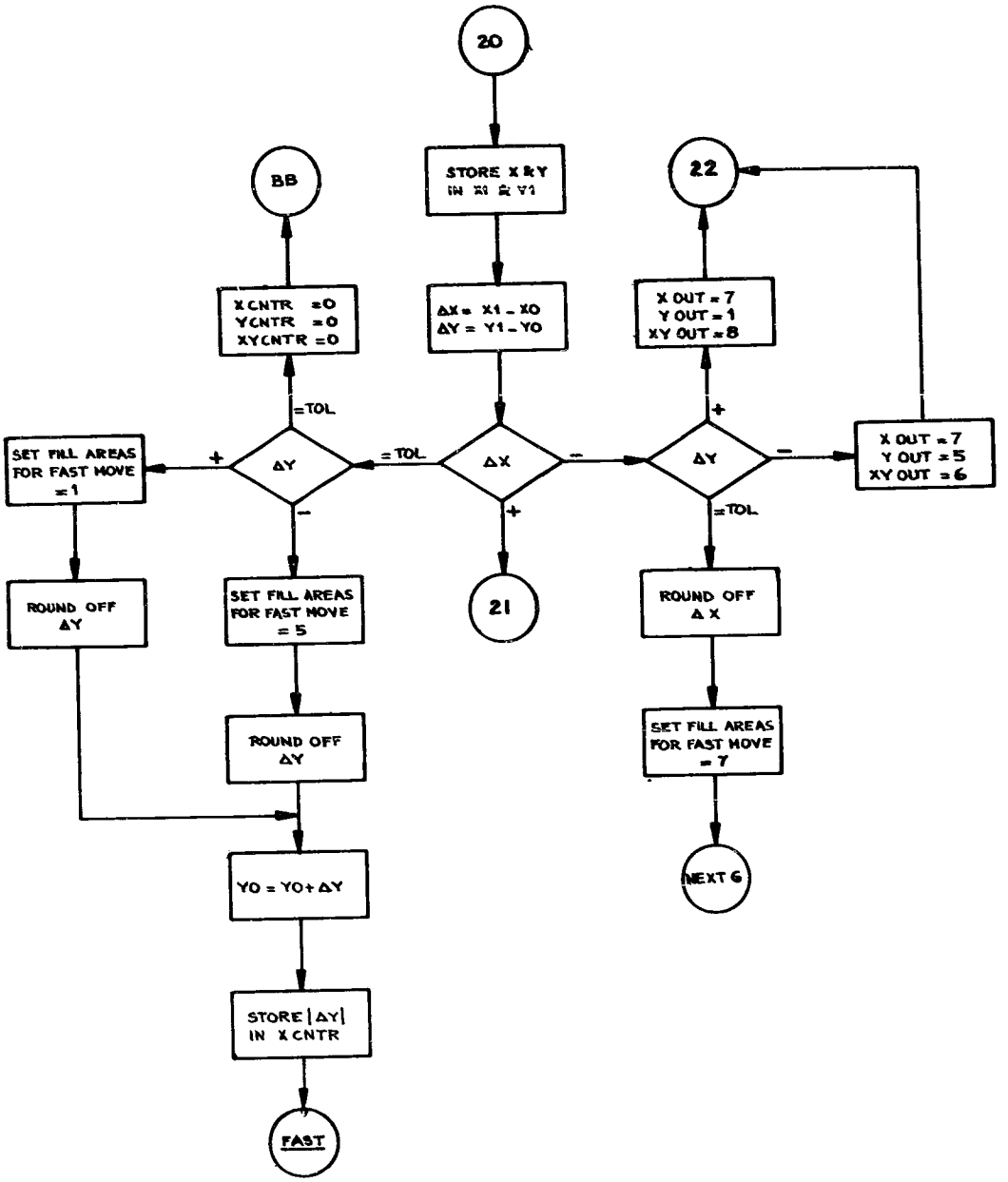
```
      * * *       SAMPLE DATA         * * *
            .5                  .5
           2.                  2.
           6.                  2.
           6.                  6.
           2.                  6.
           2.                  2.
           3.                  3.
        6000.                  0.
           5.                  5.
        5000.                  0.
           6.                  6.
        6000.                  0.
           6.                  2.
        5000.                  0.
           5.                  3.
        6000.                  0.
           2.                  6.
        5000.                  0.
           3.                  5.
           5.                  5.
           5.                  3.
           3.                  3.
           3.                  5.
```

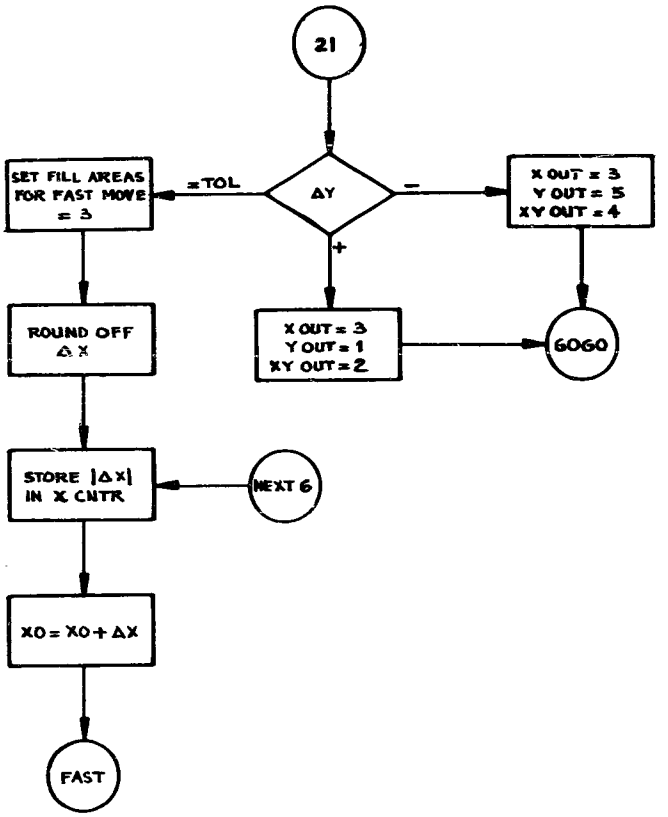
* * * SAMPLE OUTPUT * * *

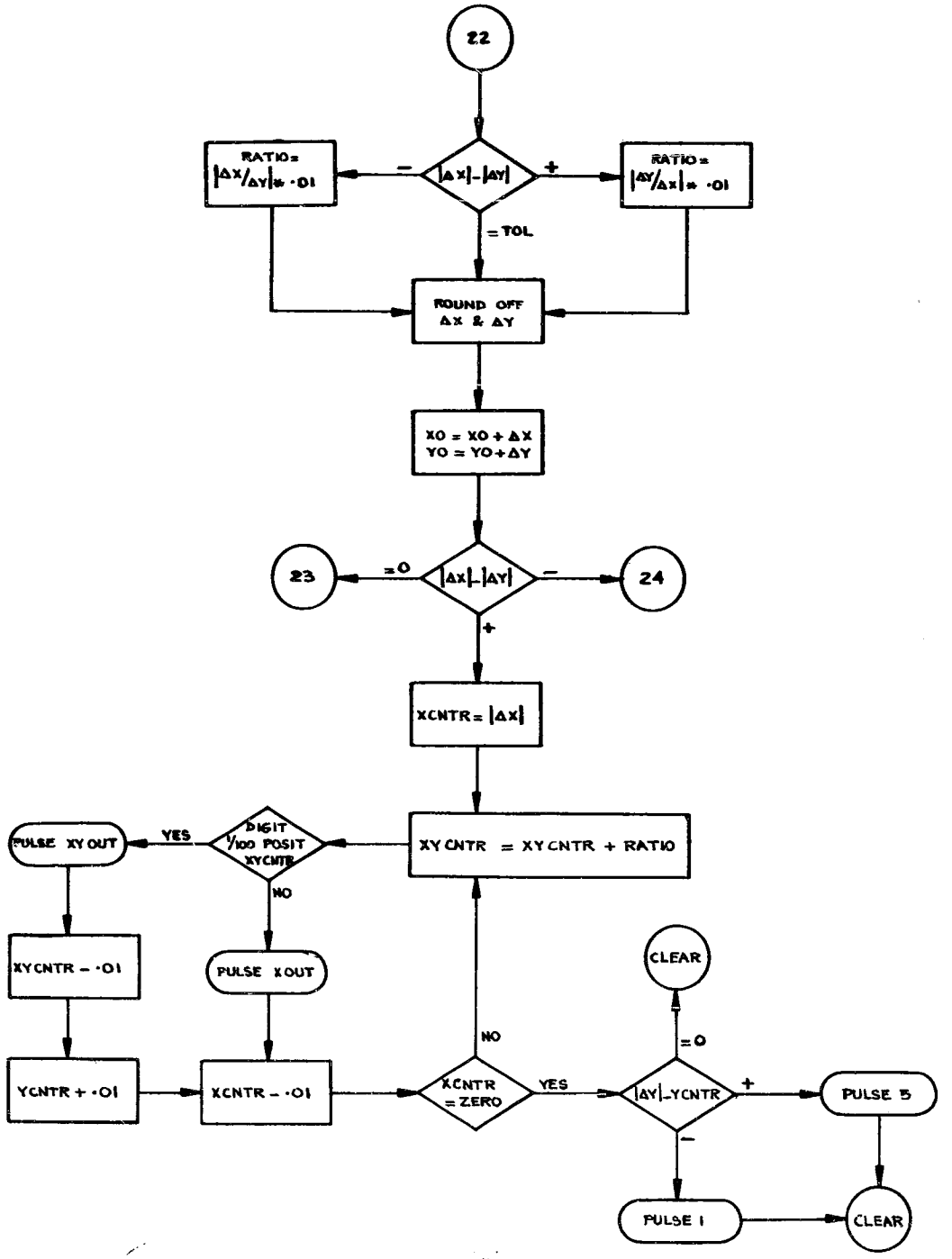


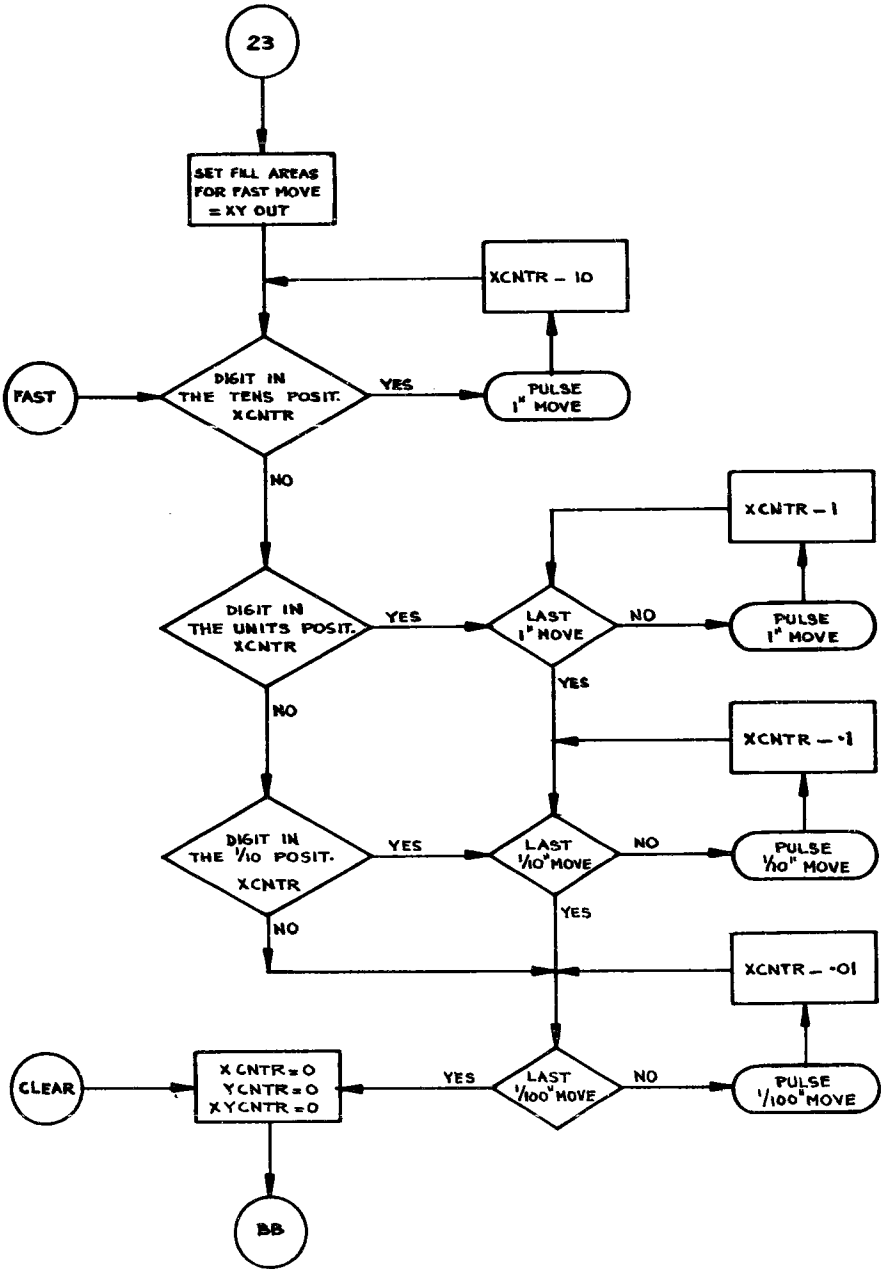
FLOW CHART OF PLOT SUB ROUTINE

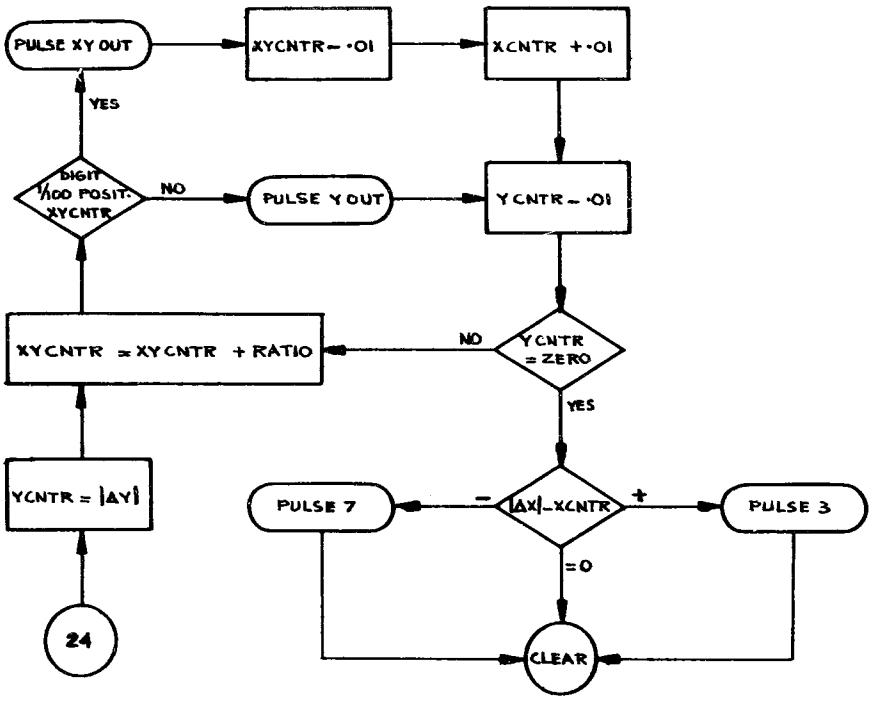



20
STORE X & Y
IN X1 & Y1
ΔX = X1 - XO
ΔY = Y1 - YO
ΔX
=TOL
+
-
ΔY
=TOL
+
-
ΔY
=TOL
+
-
BB
XCNTR =0
YCNTR =0
XYCNTR =0
SET FILL AREAS
FOR FAST MOVE
=1
ROUND OFF
ΔY
SET FILL AREAS
FOR FAST MOVE
= 5
ROUND OFF
ΔY
YO = YO+ΔY
STORE |ΔY|
IN XCNTR
FAST
21
22
X OUT = 7
Y OUT = 1
XY OUT = 8
X OUT = 7
Y OUT = 5
XY OUT = 6
ROUND OFF
Δ X
SET FILL AREAS
FOR FAST MOVE
= 7
NEXT 6


21
SET FILL AREAS FOR FAST MOVE = 3
=TOL
ΔY
−
X OUT = 3
Y OUT = 5
XY OUT = 4
+
ROUND OFF ΔX
X OUT = 3
Y OUT = 1
XY OUT = 2
6060
STORE |ΔX| IN X CNTR
NEXT 6
XO = XO + ΔX
FAST


22
RATIO= |ΔX/ΔY| * .01
|ΔX|-|ΔY|
RATIO= |ΔY/ΔX| * .01
= TOL
ROUND OFF ΔX & ΔY
XO = XO + ΔX
YO = YO + ΔY
23
=0
|ΔX|-|ΔY|
24
+
XCNTR = |ΔX|
XYCNTR = XYCNTR + RATIO
DIGIT 1/100 POSIT XYCNTR
YES
PULSE XY OUT
NO
XYCNTR - .01
PULSE X OUT
YCNTR + .01
XCNTR - .01
XCNTR = ZERO
NO
YES
CLEAR
=0
|ΔY|-YCNTR
+
PULSE 5
-
PULSE 1
CLEAR


23
SET FILL AREAS FOR FAST MOVE = XY OUT
XCNTR – 10
FAST
DIGIT IN THE TENS POSIT. XCNTR
YES
PULSE 1" MOVE
NO
XCNTR – 1
DIGIT IN THE UNITS POSIT. XCNTR
YES
LAST 1" MOVE
NO
PULSE 1" MOVE
YES
NO
XCNTR – .1
DIGIT IN THE 1/10 POSIT. XCNTR
YES
LAST 1/10" MOVE
NO
PULSE 1/10" MOVE
YES
NO
XCNTR – .01
CLEAR
X CNTR = 0
Y CNTR = 0
XY CNTR = 0
YES
LAST 1/100" MOVE
NO
PULSE 1/100" MOVE
BB


PULSE XY OUT
XYCNTR – .01
XCNTR + .01
YES
DIGIT 1/100 POSIT. XYCNTR
NO
PULSE Y OUT
YCNTR – .01
XYCNTR = XYCNTR + RATIO
NO
YCNTR = ZERO
YES
YCNTR = |ΔY|
PULSE 7
–
|ΔX|–XCNTR
+
PULSE 3
=0
24
CLEAR

PROGRAM LISTING OF "PLOT" SUBROUTINE

5.6.0

```
I-ADD OP                P/L LABEL   OP       OPERANDS

3600072005003600201005004400012002752600059002?#250001100000260009000269  -
2600095002643100000002002600114002742500000000114900012000000            -
                        0001  *   PL OT S  UBROUTINE - FORTRAN FORMAT   12/19/62#
05000                   0010         DORG  5000#
05000 K6 05023 59829    0020         TF    BOX,ARG,0,          STORE ADRESS OF THE ARGUMENT IN BOX#
05012 K0 09961 05023    0030         TF    Y,BOX,01#
05023    00005          0040  BOX    DS    5,*#
05024 J4 09961 000-5    0050         CM    Y,5,010,            TEST FOR CHARACTERISTIC EQUAL 5#
05036 M7 05216 01200    0060         BNE   *&180,,0#
05048 K0 05078 05023    0070         TF    BOX2,BOX,01#
05060 KK 05078 09931    0080         S     BOX2,FF,01,         ADJUST FOR FIELD LENGTH#
05072 J4 00000 000N0    0090         CM    ,50,010,            TEST FOR PEN DOWN#
05076    00005          0100  BOX2   DS    5,*-5#
05084 M7 05120 01200    0110         BNE   *&36,,0#
05096 L8 09905 00200    0120         WNPT  PENDWN-1,,0#
05108 42 00000 00000    0130         BB    *
05120 K0 05150 05023    0140         TF    BOX3,BOX,01#
05132 KK 05150 09931    0150         S     BOX3,FF,01,         ADJUST FOR FIELD LENGTH#
05144 J4 00000 00000    0160         CM    ,60,010,            TEST FOR PEN UP#
05150    00005          0170  BOX3   DS    5,*-5#
05156 M7 05192 01200    0180         BNE   *&36,,0,            BRANCH TO INITIATE#
05168 L8 09909 00200    0190         WNPT  PENUP-1,,0#
05180 42 00000 00000    0200         BB    *
                        0210  *  -IN ITIA  TION-#
05192 J6 09969 -0000    0220         IFM   C0,0,07,            CLEAR COUNTER TO ZERO#
05204 M9 05096 00000    0230         B     *-108,,0#
05216 K0 09923 08917    0240         TF    AX,ZERO1,01,        CLEAR AX TO ZERO#
05228 K0 09929 08917    0250         TF    AY,ZERO1,01,        CLEAR AY TO ZERO#
05240 J2 05023 000-2    0260         SM    BOX,2,010#
05252 K0 05275 05023    0270         TF    BOX1,BOX,01#
05264 K0 09959 05275    0280         TF    Y-2,BOX1,01,        STORE MANTISA OF THE ARGUMENT#
05275    00005          0290  BOX1   DS    5,*#
05276 J4 09969 000-2    0300         CM    C0,2,010,           TEST FOR COUNTER EQUAL 2#
05288 M6 05312 01200    0310         BE    *&24,,0#
05300 J1 09969 -0001    0320         AM    C0,1,07#
05312 2M 000e0 09915    0330         C     FAC,EX,1,           TEST FOR X EQUAL ZERO#
05324 M7 05346 01200    0340         BNE   MISS,,0#
05336 MV 05453 00000    0350         B     G,,0#
```

F-42

```
I-ADD OP                P/L LABEL   OP       OPERANDS

                        0570  * -CON VERT  ION OF X AND Y TO FIXED POINT VARIABLES-*
05348 2M 00060 09911    0380  MISS   C      FAC,EX2,1,          TEST FOR X WITH 2 INTEGERS*
05360 M6 05672 01100    0390         BP     GABOR,,0*
05372 M6 05732 01200    0400         BE     FIX2,,0*
05384 2M 00060 09913    0410         C      FAC,EX0,1,          TEST FOR X WITHOUT INTEGERS*
05396 M6 05804 01100    0420         BP     FIX1,,0*
05408 M6 05870 01200    0430         BE     FIX0,,0*
05420 2M 00060 09917    0440         C      FAC,EXM2,1,         TEST FOR CHARACTERISTIC OF X # -2*
05432 M6 05948 01100    0450         BP     FIXM1,,0*
05444 M6 06008 01200    0460         BE     FIXM2,,0*
05456 KO 09923 08917    0470         TF     AX,ZERO1,01,        SET AX#0 FOR CHARACT. LESS THAN -2*
05468 KM 09961 09915    0480  G      C      Y,EX,01,            TEST FOR Y EQUAL ZERO*
05480 M7 05540 01200    0490         BNE    *E60,,0*
05492 KO 09929 08917    0500         TF     AY,ZERO1,01*
05504 2M 00060 09915    0510         C      FAC,EX,1,           TEST FOR X EQUAL ZERO*
05516 M6 06512 01200    0520         BE     FIRST,,0*
05528 M9 06476 00000    0530         B      F,,0*
05540 KM 09961 09911    0540         C      Y,EX2,01,           TEST FOR Y WITH 2 INTEGERS*
05552 M6 06080 01100    0550         BP     FIXY3,,0*
05564 M6 06140 01200    0560         BE     FIXY2,,0*
05576 KM 09961 09913    0570         C      Y,EX0,01,           TEST FOR Y WITHOUT INTEGERS*
05588 M6 06212 01100    0580         BP     FIXY1,,0*
05600 M6 06284 01200    0590         BE     FIXY0,,0*
05612 KM 09961 09917    0600         C      Y,EXM2,01,          TEST FOR CHARACTERISTIC OF Y # -2*
05624 M6 06356 01100    0610         BP     FIXYM1,,0*
05636 M6 06416 01200    0620         BE     FIXYM2,,0*
05648 KO 09929 08917    0630         TF     AY,ZERO1,01,        SET AY#0 FOR CHARACT. LESS THAN -2*
05660 M9 06476 00000    0640         B      F,,0*
                        0650  * -SEC TION   CORRESPONDING TO VALUES OF X WITH 3 INTEGERS-*
05672 J6 05719 -0060    0660  GABOR  TFM    BOX4,FAC,07*
05684 KK 05719 09951    0670         S      BOX4,FF,01,         ADJUST FOR FIELD LENGTH*
05696 J1 05719 0004     0680         AM     BOX4,4,010*
05708 K6 09923 00000    0690         TF     AX,,0*
05719    00005          0700  BOX4   DS     5,**
05720 M9 05948 00000    0710         B      G,,0*
                        0720  * -SEC TION   CORRESPONDING TO VALUES OF X WITH 2 INTEGERS-*
05732 J6 05779 -0060    0730  FIX2   TFM    BOX5,FAC,07*
05744 KK 05779 09951    0740         S      BOX5,FF,01,         ADJUST FOR FIELD LENGTH*
```

```
 I-ADD OP                    P/I LABEL   OP      OPERANDS

05756 J1 05779 000-3 0750           AM    BOX5,3,010*
05768 K6 09923 00000 0760           TF    AX,,0*
05779    00005       0770 BOX5      DS    5,**
05780 L3 09919 00000 0780           CF    AX-4,,0*
05792 M9 05468 00000 0790           B     G,,0*
                     0800 * -SEC TION   CORRESPONDING TO VALUES OF X WITH 1 INTEGER-*
05804 J6 05851 -0060 0810 FIX1      TFM   BOX6,FAC,07*
05816 KK 05851 09931 0820           S     BOX6,FF,01,          ADJUST FOR FIELD LENGTH*
05828 J1 05851 000-2 0830           AM    BOX6,2,010*
05840 K6 09923 00000 0840           TF    AX,,0*
05851    00005       0850 BOX6      DS    5,**
05852 L3 09920 00000 0860           CF    AX-3,,0*
05864 M9 05468 00000 0870           B     G,,0*
                     0880 * -SEC TION   CORRESPONDING TO VALUES OF X WITHOUT INTEGERS*
05876 J6 05923 -0060 0890 FIX0      TFM   BOX7,FAC,07*
05888 KK 05923 09931 0900           S     BOX7,FF,01,          ADJUST FOR FIELD LENGTH*
05900 J1 05923 000-1 0910           AM    BOX7,1,010*
05912 K6 09923 00000 0920           TF    AX,,0*
05923    00005       0930 BOX7      DS    5,**
05924 L3 09921 00000 0940           CF    AX-2,,0*
05936 M9 05468 00000 0950           B     G,,0*
                     0960 * -SEC TION   FOR CHARACTERISTIC OF X #-1 -*
05948 J6 05995 -0060 0970 FIXM1     TFM   BOX8,FAC,07*
05960 KK 05983 09931 0980           S     BOX8,FF,01,          ADJUST FOR FIELD LENGTH*
05972 K6 09923 00000 0990           TF    AX,,0*
05983    00005       1000 BOX8      DS    5,**
05984 L3 09922 00000 1010           CF    AX-1,,0*
05996 M9 05468 00000 1020           B     G,,0*
                     1030 * -SEC TION   FOR CHARACTERISTIC OF X #-2 -*
06008 J6 06055 -0060 1040 FIXM2     TFM   BOX9,FAC,07*
06020 KK 06055 09931 1050           S     BOX9,FF,01,          ADJUST FOR FIELD LENGTH*
06032 J2 06055 000-1 1060           SM    BOX9,1,010*
06044 K5 09923 00000 1070           TD    AX,,0*
06055    00005       1080 BOX9      DS    5,**
06056 L3 09923 00000 1090           CF    AX,,0*
06068 M9 05468 00000 1100           B     G,,0*
                     1110 * -SEC TION   FOR VALUES OF Y WITH 3 INTEGERS-*
06080 J0 06127 -9961 1120 FIXY3     TFM   BOX10,Y,017*
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 I-ADD OP              P/L LABEL   OP       OPERANDS

06092 KK 06127 09931 1130          S      BOX10,FF,01,        ADJUST FOR FIELD LENGTH*
06104 J1 06127 000-4 1140          AM     BOX10,4,010*
06116 K0 09929 00000 1150          TF     AY,,01*
06127    00005       1160  BOX10   DS     5,**
06128 M9 06476 00000 1170          B      F,,0*
                     1180  * -SEC TION    FOR VALUES OF Y WITH 2 INTEGERS-*
06140 J0 06187 -9961 1190  FIXY2   TFM    BOX11,Y,017*
06152 KK 06187 09931 1200          S      BOX11,FF,01,        ADJUST FOR FIELD LENGTH*
06164 J1 06187 000-3 1210          AM     BOX11,3,010*
06176 K0 09929 00000 1220          TF     AY,,01*
06187    00005       1230  BOX11   DS     5,**
06192 L3 09925 00000 1240          CF     AY-4,,0*
06200 M9 06476 00000 1250          B      F,,0*
                     1260  * -SEC TION    FOR VALUES OF Y WITH 1 INTEGER-*
06212 J0 06259 -9961 1270  FIXY1   TFM    BOX12,Y,017*
06224 KK 06259 09931 1280          S      BOX12,FF,01,        ADJUST FOR FIELD LENGTH*
06236 J1 06259 000-2 1290          AM     BOX12,2,010*
06248 K0 09929 00000 1300          TF     AY,,01*
06259    00005       1310  BOX12   DS     5,**
06260 L3 09926 00000 1320          CF     AY-3,,0*
06272 M9 06476 00000 1330          B      F,,0*
                     1340  * -SEC TION    FOR VALUES OF Y WITHOUT INTEGERS-*
06284 J0 06331 -9961 1350  FIXY0   TFM    BOX13,Y,017*
06296 KK 06331 09931 1360          S      BOX13,FF,01,        ADJUST FOR FIELD LENGTH*
06308 J1 06331 000-1 1370          AM     BOX13,1,010*
06320 K0 09929 00000 1380          TF     AY,,01*
06331    00005       1390  BOX13   DS     5,**
06332 L3 09927 00000 1400          CF     AY-2,,0*
06344 M9 06476 00000 1410          B      F,,0*
                     1420  * -SEC TION    FOR CHARACTERISTIC OF Y #-1 -*
06356 J0 06391 -9961 1430  FIXYM1  TFM    BOX14,Y,017*
06368 KK 06391 09931 1440          S      BOX14,FF,01,        ADJUST FOR FIELD LENGTH*
06380 K0 09929 00000 1450          TF     AY,,01*
06391    00005       1460  BOX14   DS     5,**
06392 L3 09928 00000 1470          CF     AY-1,,0*
06404 M9 06476 00000 1480          B      F,,0*
                     1490  * -SEC TION    FOR CHARACTERISTIC OF Y #-2*
06416 J0 06463 -9961 1500  FIXYM2  TFM    BOX15,Y,017*
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LOCN OP                    PVL LABEL   OP        OPERANDS

06428 KK 06463 09961 1610            J       SCALE,CF,01,        ADJUST NO. FIELD FRACTION*
06440 J2 06463 000-1 1620            SM      SCALE,1,0104
06452 KM 09924 00000 1630            IC      AY,,0**
06463    00000       1640  SCALE     DS      5,,0*
06469 L3 09924 00000 1650            CP      AY,,0*
06476 P1 09924 00000 1660  F         MP      AX,,SCALE,0*        TEST FOR NEGATIVE X*
06489 MM 06516 09961 1670            INF     F1,S1,,2,,1,        IF,S FOR NEGATIVE X*
06500 L4 09924 00000 1680            SF      AY,,0*
06512 J4 09969 -0001 1690  FIRST     CM      CO,1,0T,            TEST FOR COUNTER EQUAL 1*
06524 M6 06574 01100 1700            MP      ALL,,0*
06536 K0 09961 09925 1710            TF      XO,AX,01,           INITIAL VALUE X*0
06548 K0 09961 09926 1720            TF      YO,AY,01,           INITIAL VALUE YO*
06560 42 00000 00000 1730            BB      *
06572 K0 09961 09925 1740  ALL       TF      X1,AX,01*
06584 K0 09967 09929 1750            TF      Y1,AY,01*
06596 L3 09925 00000 1760            SF      DELTAX,X1,,0*
06608 KP 09925 09926 1770            S       DELTAX,XO,01,       TOTAL INCREMENT IN THE X DIRECTION*
06620 K0 09897 09925 1780            TF      ABSDX,DELTAX,01*
06632 L3 09897 00000 1790            CF      ABSDX,,0*
06644 K0 09897 09967 1800            TF      DELTAY,Y1,01*
06656 KP 09897 09929 1810            S       DELTAY,YO,01,       TOTAL INCREMENT IN THE Y DIRECTION*
06668 K0 09897 09967 1820            TF      ABSDY,DELTAY,01*
06680 L3 09967 00000 1830            CF      ABSDY,,0*
06692 KM 09897 09914 1840            C       ABSDX,TOLER,01,     TEST FOR ABSDX LESS THAN .0001*
06704 M6 06726 01100 1850            BP      *+24,,0*
06716 M3 06732 00030 1860            B       NEXT6,,04
06728 KM 09880 09917 1870            C       DELTAX,ZERO1,01,    TEST FOR DELTAX = 0*
06740 M0 06756 01100 1880            BP      NEXT2,,0*
06752 KM 09903 09914 1890            C       ABSDY,TOLER,01,     TEST FOR ABSDY LESS THAN .0001*
06764 M3 06784 01100 1900            BP      *+2*,,01
06776 M3 06808 00030 1910            B       NEXT6,,01
06788 KM 09891 09917 1920            C       DELTAY,ZERO1,01,    TEST FOR DELTAY = 0*
06800 M4 06822 01100 1930            BP      NEXT3,,0*
                         1940  * CALCULATIV  E DELTAX AND DELTAY-*
06812 J0 07236 -9764 1950            IFM     YOUT,SIXSO-1,017*
06824 J0 07610 -9766 1960            IFM     YOUT,FIVE0-1,017*
06836 J0 07456 -9768 1970            IFM     XYOUT,SIXSO-1,017*
06848 J0 07456 -9766 1980            IFM     G0XY266,SIXSO-1,017*
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LOC    OBJECT CODE    ADDR1  ADDR2  STMT  SOURCE STATEMENT
                                     1870          B       GOXY2LOC,FOURC-1,017*
                                     1900  * --POS ITIV    C DELTAX AND POSITIVE DELTA Y-*
06872 4B 07230 -9784  1910  NEXT5   BAL     XOUT,XCNTR-1,017*
06884 4B 07610 -9860  1920          BAL     YOUT,YCNTR-1,017*
06896 4B 07463 -9778  1930          BAL     XYOUT,RATIO-1,017*
06908 4B 07854 -9878  1940          BAL     GOXY2LOC,RATIO-1,017*
06920 4A 07100 03000  1950          A       GOOX,=1*
                                     1960  * --POS ITIV    C DELTAX-*
06932 4A 07908 09964  1970  NEXT2   C       ABSDY,DELTAY-1,01,     TEST FOR ABSDY LESS THAN DELTAY*
06944 47 0696F 01100  1980          BP      *+2*,,3*
06956 40 07654 00000  1990          B       NEXT6,,0*
06968 4A 07941 09917  2000          C       DELTAY,ZERO-1,01,      TEST FOR DELTAY = 0*
06980 47 07052 01100  2010          BP      NEXT4,,0*
                                     2020  * --POS ITIV    C DELTAX AND NEGATIVE DELTAY-*
06992 4B 07258 -9508  2030          BAL     XOUT,THRSO-1,017*
07004 4B 07610 -9596  2040          BAL     YOUT,FIVEO-1,017*
07016 4B 07460 -9672  2050          BAL     XYOUT,FOURO-1,017*
07028 4B 07854 -9863  2060          BAL     GOXY2LOC,FOURC-1,017*
07040 4A 07100 00000  2070          B       GOGO,,0*
                                     2080  * --POS ITIV    C DELTAX AND DELTAX-*
07052 4B 07258 -9508  2090  NEXT4   BAL     XOUT,THRE0-1,017*
07064 4B 07610 -9596  2100          BAL     YOUT,FIVE0-1,017*
07076 4B 07460 -9174  2110          BAL     XYOUT,TWOSO-1,017*
07088 4B 07536 -9174  2120          BAL     GOXY2LOC,TWOSO-1,017*
07100 KM 09897 09903  2130  GOGO    C       ABSDX,ABSDY,01,        TEST FOR BIGGER INCREMENT*
07112 M8 07380 01200  2140          BE      OK,,3*
07124 K7 0750e -1503  2200          BM      YeloOR,,0*
                                     2210  * --DEL TAX     GREATER THAN DELTAY-*
07136 2B 08096 09903  2220          CD      *+6,ABSDY,3*
07148 2A 09097 09897  2230          D       97,=ABSDX,1*
07160 52 08091 00000  2240          SP      91*
07172 K6 08942 08093  2250          TP      RATIO,=3.0,            RATIO DELTAY/DELTAX*
07184 47 07081 00000  2260          BP      OK,,3*
                                     2270  * --DEL TAX     GREATER THAN DELTAY-*
07196 KJ 09721 09784  2280          TP      XCNTR,DELTAX-1,01, SET XCOUNTER EQUAL TO DELTA X
07208 KJ 09735 08943  2290  GO2     A       XYCNTR,RATIO,01.       MODIFY XYCOUNTER ADDING RATIO*
07220 ML 07460 08952  2300          BO      GOXY1,XYCNTR-3,01,     TEST FOR DIGIT IN XYCOUNTER*
07232 56 00000 00200  2310          WNPT    *
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   I-ADD OP                P/L LABEL   OP       OPERANDS

07238     00005          2320  XOUT    DS       5,*-5*
07244 J2  08923 000-1    2330  G03     SM       XCNTR,1,010*
07256 J4  08923 -0000    2340          CM       XCNTR,0,07,          TEST FOR LAST MOVE*
07268 M6  07208 01100    2350          BP       G02,,0*
                         2360  * -FIN  AL A     DJUSTMENT IN THE Y DIRECTION-*
07280 MM  07376 09891    2370          BNF      *E96,DELTAY,01,      TEST FOR NEGATIVE DELTAY*
                         2380  * -NEG  ATIV     E DELTAY-*
07292 KM  09890 08928    2390          C        DELTAY-1,YCNTR-1,01,TEST FOR FINAL ADJUSTMENT*
07304 M6  08048 01200    2400          BE       CLEAR,,0*
07316 M7  07352 01300    2410          BN       *E36,,0*
07328 L8  09536 00200    2420          WNPT     FIVE0-1,,0*
07340 M9  08048 00000    2430          B        CLEAR,,0*
07352 L8  09080 00200    2440          WNPT     ONE50-1,,0*
07364 M9  08048 00000    2450          B        CLEAR,,0*
                         2460  * -POS  ITIV     E DELTAY-*
07376 KM  09890 08926    2470          C        DELTAY-1,YCNTR-1-01,TEST FOR FINAL ADJUSTMENT*
07388 M6  08048 01200    2480          BE       CLEAR,,0*
07400 M7  07436 01300    2490          BN       *E36,,0*
07412 L8  09080 00200    2500          WNPT     ONE50-1,,0*
07424 M9  08048 00000    2510          B        CLEAR,,0*
07436 L8  09536 00200    2520          WNPT     FIVE0-1,,0*
07448 M9  08048 01200    2530          B        CLEAR,,0*
                         2540  * -DIG  IT I     N XYCOUNTER *DELTAX GRATER THAN DELTAY0-*
07460 38  00000 00200    2550  GOXY1   WNPT     *
07466     00005          2560  XYOUT   DS       5,*-5*
07472 J2  08935 00000    2570          SM       XYCNTR,1000,08*
07484 J1  08929 00030    2580          AM       YCNTR,10,010*
07496 M9  07244 00000    2590          B        G03,,0*
                         2600  * -DEL  TAY      LARGER THAN DELTAX-*
07508 2Q  00096 09897    2610  YBIGER  LD       96,ABSDX,1*
07520 2R  00097 09903    2620          D        97,ABSDY,1*
07532 32  00091 00000    2630          SF       91*
07544 K6  08943 00093    2640          TF       RATIO,93,0*
07556 M9  07680 00000    2650          B        OK,,0*
                         2660  * DELT  AY L     ARGER THAN DELTAX*
07568 KO  08929 09890    2670          TF       YCNTR,DELTAY-1,01, SET YCOUNTER EQUAL TO DELTAY*
07580 KJ  08935 08943    2680  G04     A        XYCNTR,RATIO,01,   MODIFY XYCOUNTER ADDING RATIO*
07592 ML  07832 08932    2690          BD       GOXY2,XYCNTR-3,01, TEST FOR DIGIT IN XYCOUNTER*

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 I-ADD OP                P/L LABEL   OP      OPERANDS

07808 38 00000 00200 2700          WNPT   *
07810    00005        2710 YOUT    DS     5,*-5*
07816 J2 08929 000-1 2720 GO5      SM     YCNTR,1,010*
07828 J4 08929 -0000 2730          CM     YCNTR,0,07,        TEST FOR LAST MOVE*
07840 M6 07580 01100 2740          BP     G04,,0*
                     2750 * -FIN AL A  DJUSTMENT IN THE X DIRECTION-*
07852 MM 07748 09885 2760          BNF    *&9o,DELTAX,01,    TEST FOR NEGATIVE DELTAX*
                     2770 * -NEG ATIV  E DELTAX-*
07864 KM 09884 08922 2780          C      DELTAX-1,XCNTR-1,01,TEST FOR FINAL ADJUSTMENT*
07876 M6 08048 01200 2790          BE     CLEAR,,0*
07888 M7 07724 01300 2800          BN     *&36,,0*
07900 L8 09764 00200 2810          WNPT   SEVSO-1,,0*
07912 M9 08048 00000 2820          B      CLEAR,,0*
07924 L8 09308 00200 2830          WNPT   THREO-1,,0*
07936 M9 08048 00000 2840          B      CLEAR,,0*
                     2850 * -POS ITIV  E DELTAX-*
07948 KM 09884 08922 2860          C      DELTAX-1,XCNTR-1,01,TEST FOR FINAL ADJUSTMENT*
07960 M6 08048 01200 2870          BE     CLEAR,,0*
07972 M7 07808 01300 2880          BN     *&36,,0*
07984 L8 09308 00200 2890          WNPT   THREO-1,,0*
07996 M9 08048 00000 2900          B      CLEAR,,0*
08008 L8 09764 00200 2910          WNPT   SEVSO-1,,0*
08020 M9 08048 01200 2920          B      CLEAR,,0*
                     2930 * -DIG IT I  N XYCOUNTER &DELTAY LARGER THAN DELTAX&-*
07832 38 00000 00200 2940 GOXY2    WNPT   *
07844 J2 08935 -1000 2950          SM     XYCNTR,1000,07*
07856 J1 08923 000J0 2960          AM     XCNTR,10,010*
07868 M9 07616 00000 2970          B      G05,,0*
                     2980 * -DEL TAX   EQUAL TO DELTAY-*
07880 PJ 09882 09885 2990 OK       MF     DELTAX-3,DELTAX,01*
07892 J1 09885 000-5 3000          AM     DELTAX,5,010,      ROUND OFF DELTAX*
07904 J5 0988: 00000 3010          TDM    DELTAX,0,0*
07916 PJ 09885 09882 3020          MF     DELTAX,DELTAX-3,01*
07928 KJ 08949 09885 3030          A      X0,DELTAX,01,      ADJUST X0*
07940 PJ 09888 09891 3040          MF     DELTAY-3,DELTAY,01*
07952 J1 09891 000-5 3050          AM     DELTAY,5,010,      ROUND OFF DELTAY*
07964 J5 09891 00000 3060          TDM    DELTAY,0,0*
07976 PJ 09891 09888 3070          MF     DELTAY,DELTAY-3,01*
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I-ADD OP              P/L LABEL   OP       OPERA..DS

07988 KJ 08955 09891 3080          A      YO,DELTAY,01,       ADJUST YO*
08000 KM 09884 09890 3090          C      DELTAX-1,DELTAY-1,01,TEST FOR LARGER INCREMENT*
08012 M7 07568 01500 3100          BN     GO4-12,,0*
08024 M6 08096 01200 3110          BE     XYGO,,0*
08036 M9 07196 00000 3120          B      GO2-12,,0*
                     3130  * -CLE AR X  COUNTER AND YCOUNTER TO ZEROS AND SET XYCOUNTER =.005 -*
08048 J6 08935 -0005 3140  CLEAR   IBM    XYCNTR,5,07*
08060 K0 08923 08917 3150          TF     XCNTR,ZERO1,01*
08072 K0 08929 08917 3160          TF     YCNTR,ZERO1,01*
08084 42 00000 00000 3170          BB     *
                     3180  * DELT AX E  QUAL TO DELTAY*
08096 K0 08246 07466 3190  XYGO    TF     FILL1,XYOUT,01*
08108 J2 07466 00001 3200          SM     XYOUT,1,010*
08120 K0 08306 07466 3210          TF     FILL2,XYOUT,01*
08132 J2 07466 00101 3220          SM     XYOUT,101,09*
08144 K0 08366 07466 3230          TF     FILL3,XYOUT,01*
08156 K0 08414 07466 3240          TF     FILL4,XYOUT,01*
08168 K0 08922 09884 3250          TF     XCNTR-1,DELTAX-1,01,SET XCOUNTER EQUAL TO DELTAX*
08180 ML 08596 08919 3260  FAST    BD     TENS,XCNTR-4,01,    TEST FOR DIGIT IN THE TENS POSITION*
08192 ML 08336 08920 3270          BD     UNITS,XCNTR-3,01,   TEST FOR DIGIT IN THE UNITS POSIT.*
08204 ML 08276 08921 3280          BD     TENTHS,XCNTR-2,01,  TEST FOR DIGIT IN THE 1/10 POSIT.*
08216 J4 08922 -0000 3290  LAST    CM     XCNTR-1,0,07,       TEST FOR LAST SINGLE MOVE*
08228 M7 08048 01100 3300          BNP    CLEAR,,0*
08240 38 00000 00200 3310          WNPT   *
08246    00005       3320  FILL1   DS     5,*-5*
08252 J2 08922 000-1 3330          SM     XCNTR-1,1,010*
08264 M9 08216 00000 3340          B      LAST,,0*
08276 J4 08921 0-000 3350  TENTHS  CM     XCNTR-2,0,08,       TEST FOR LAST 1/10 INCH MOVE*
08288 M7 08216 01100 3360          BNP    LAST,,0*
08300 38 00000 00200 3370          WNPT   *
08306    00005       3380  FILL2   DS     5,*-5*
08312 J2 08921 000-1 3390          SM     XCNTR-2,1,010*
08324 M9 08276 00000 3400          B      TENTHS,,0*
08336 J4 08920 00-00 3410  UNITS   CM     XCNTR-3,0,09,       TEST FOR LAST ONE INCH MOVE*
08348 M7 08276 01100 3420          BNP    TENTHS,,0*
08360 38 00000 00200 3430          WNPT   *
08366    00005       3440  FILL3   DS     5,*-5*
08372 J2 08920 000-1 3450          SM     XCNTR-3,1,010*
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 I-ADD OP              P/L LABEL   OP      OPERANDS

08384 M7 08836 00000 3460          B      UNITS,,0*
08396 J2 08920 000-1 3470  TENS    SM     XCNTR-3,1,010*
08408 38 00000 00200 3480          WNPT    *
08414    00005       3490  FILL4   DS     5,*-5*
08420 M9 08180 00000 3500          B      FAST,,0*
                     3510  * -DEL  TAX    EQUAL ZERO-*
08432 KM 09903 09964 3520  NEXT5   C      ABSDY,TOLER,01,     TEST FOR ABSDY LESS THAN .005*
08444 M6 08468 01100 3530          BP     *624,,0*
08456 M9 08048 00000 3540          B      CLEAR,,0*
08468 KM 09891 05917 3550          C      DELTAY,ZERO1,01,    TEST FOR DELTAY EQUAL ZERO*
08480 M6 08576 01100 3560          BP     NEXT55,,0*
                     3570  * -DEL  TAX    EQUAL ZERO AND NEGATIVE DELTAY-*
08492 J0 08246 -9536 3580          TFM    FILL1,FIVE0-1,017*
08504 J0 08306 -9525 3590          TFM    FILL2,FIVET-10,017*
08516 J0 08366 -9424 3600          TFM    FILL3,FIVEH-49,017*
08528 J0 08414 -9424 3610          TFM    FILL4,FIVEH-49,017*
08540 J2 09891 000-5 3620          SM     DELTAY,5,010,       ROUND OFF DELTAY*
08552 J5 09891 0000- 3630          TDM    DELTAY,,011*
08564 M9 08648 00000 3640          B      NEXTY,,0*
                     3650  * -DEL  TAX    EQUAL ZERO AND POSITIVE DELTAY-*
08576 J0 08246 -9080 3660  NEXT55  TFM    FILL1,ONES0-1,017*
08588 J0 08306 -9069 3670          TFM    FILL2,ONEST-10,017*
08600 J0 08366 -8968 3680          TFM    FILL3,ONESH-49,017*
08612 K0 08414 08366 3690          TF     FILL4,FILL3,01*
08624 J1 09891 000-5 3700          AM     DELTAY,5,010,       ROUND OFF DELTAY*
08636 J5 09891 00000 3710          TDM    DELTAY,0,0*
08648 K0 08922 09890 3720  NEXTY   TF     XCNTR -1,DELTAY-1,01,SET XCOUNTER EQUAL TO DELTAY*
08660 KJ 08955 09891 3730          A      Y0,DELTAY,01,       ADJUST Y0*
08672 M9 08180 00000 3740          B      FAST,,0*
                     3750  * -DEL  TAY    EQUAL ZERO-*
08684 MM 08804 09885 3760  NEXT6   BNF    NEXT66,DELTAX,01,   TEST FOR NEGATIVE DELTAX*
                     3770  * -DEL  TAY    EQUAL ZERO AND NEGATIVE DELTAX-*
08696 J2 09885 000-5 3780          SM     DELTAX,5,010,       ROUND OFF DELTAX*
08708 J5 09885 0000- 3790          TDM    DELTAX,0,011*
08720 J0 08246 -9764 3800          TFM    FILL1,SEVS0-1,017*
08732 J0 08306 -9753 3810          TFM    FILL2,SEVST-10,017*
08744 J0 08366 -9652 3820          TFM    FILL3,SEVSH-49,017*
08756 K0 08414 08366 3830          TF     FILL4,FILL3,01*
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1-APD 00          P/L LABEL  00        OPERANDS

08769 KC 08920 09004 3860          TI    XCNTR,1,DELTAX-1,01,SET XCOUNTER EQUAL TO DELTAX*
08780 KJ 08949 09805 3850          A     X0,DELTAX,01,       ADJUST X0*
08792 M7 08180 00009 3860          B     FAST,,0*
                        3870  * -DELTAY  MODEL ZERO AND POSITIVE DELTAX-*
08804 J0 08246 -9308 3880  NEXT66  IFM   FILL1,THR,0-1,0)*
08816 J0 08306 -9297 3890          IFM   FILL2,THR,1-10,01)*
08828 J0 08366 -9286 3900          IFM   FILL3,THR,2-99,01)*
08840 K0 08414 08366 3910          IF    FILL4,FILL3,01*
08852 J1 09885 000-5 3920          AM    DELTAX,5,010;       ROUND OFF DELTAX*
08864 J5 09865 00000 3930          IDM   DELTAX,0,0*
08876 K0 08922 07884 3940          IF    XCNTR-1,DELTAX-1,01,SET XCOUNTER EQUAL TO DELTAX*
08888 KJ 08944 08918 3950          A     X0,DELTAX,01;       ADJUST X0*
08900 M7 08180 00009 3960          B     FAST,,0*
08917     00006         3970  ZERO1   DC    6,0*
39700-000006*                                                    -6-8912-8917-
08923     00006         3980  XCNTR   DC    6,0*
39800-000006*                                                    -6-8918-8924-
08929     00006         3990  YCNTR   DC    6,0*
39900-000006*                                                    -6-8924-8930-
08935     00006         4000  XYCNTR  DC    6,5*
40000-000006*                                                    -6-8930-8936-
08941     00006         4010  RATIO   DS    8*
08949     00006         4020  X0      DS    6,,,                X VALUE OF THE PEN AFTER EACH MOVE*
08955     00006         4030  Y0      DS    6,,,                Y VALUE OF THE PEN AFTER EACH MOVE*
08961     00006         4040  X1      DS    6,,,                COORDINATE X OF THE NEW POINT*
08967     00006         4050  Y1      DS    6,,,                COORDINATE Y OF THE NEW POINT*
09017     00050         4060  ONESH   DC    50,1111111111111111111111111111111111111111111111111*
40600J1111111111111111111111111111111111111111111111111*          -6-8950-9017-
09067     00050         4070          DC    50,1111111111111111111111111111111111111111111111111*
40700J1111111111111111111111111111111111111111111111111*          -6-9018-9068-
09068     00001         4080          DC    1,,*
40800*                                                           -6-9068-9069-
09079     00011         4090  ONEST   DC    11,11111111111*
40900J11111111111*                                               -6-9070-9080-
09081     00002         4100  ONESC   DC    2,1C*
41000J*                                                          -6-9080-9082-
09131     00050         4110  TWOSH   DC    50,22222222222222222222222222222222222222222222222222*
41100K22222222222222222222222222222222222222222222222222*          -6-9082-9132-
```

5.0.0

5.52

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 I-ADD OP              P/L LABEL   OP        OPERANDS
09181     00050       4130        DC     50,2222222222222222222222222222222222222222222222222
41200K22222222222222222222222222222222222222222222222222222222222222222222222222222222222222*     -6-9182-9182-
09182     00001       4180        DC     1,44
41300*                                                                                               -6-9183-9183-
09183     00011       4140  TWOST DC     11,22222222224*
41400K2222222224*                                                                                    -6-9193-9194-
09195     00002       4150  TWOSO DC     2,2*
41500K*                                                                                              -6-9194-9196-
09245     00050       4160  THREH DC     50,33333333333333333333333333333333333333333333333333333
41600L33333333333333333333333333333333333333333333333333333333333333333333333333333333333333*     -6-9196-9246-
09295     00050       4170        DC     50,33333333333333333333333333333333333333333333333333333
41700L33333333333333333333333333333333333333333333333333333333333333333333333333333333333333*     -6-9246-9296-
09296     00001       4180        DC     1,4*
41800*                                                                                               -6-9296-9297-
09297     00011       4190  THREI DC     11,3333333333*
41900L3333333334*                                                                                    -6-9297-9308-
09309     00002       4200  THREO DC     2,3I*
42000L*                                                                                              -6-9308-9310-
09359     00050       4210  FOURH DC     50,44444444444444444444444444444444444444444444444444444
42100M44444444444444444444444444444444444444444444444444444444444444444444444444444444444444*     -6-9310-9360-
09409     00050       4220        DC     50,44444444444444444444444444444444444444444444444444444
42200M44444444444444444444444444444444444444444444444444444444444444444444444444444444444444*     -6-9360-9410-
09410     00001       4230        DC     1,4*
42300*                                                                                               -6-9410-9411-
09421     00011       4240  FOURI DC     11,4444444444*
42400M4444444444*                                                                                    -6-9411-9422-
09423     00002       4250  FOURO DC     2,44*
42500M*                                                                                              -6-9422-9424-
09473     00050       4260  FIVEH DC     50,55555555555555555555555555555555555555555555555555555
42600N55555555555555555555555555555555555555555555555555555555555555555555555555555555555555*     -6-9424-9474-
09523     00050       4270        DC     50,55555555555555555555555555555555555555555555555555555
42700N55555555555555555555555555555555555555555555555555555555555555555555555555555555555555*     -6-9474-9524-
09524     00001       4280        DC     1,4*
42800*                                                                                               -6-9524-9525-
09535     00011       4290  FIVEI DC     11,5555555555*
42900N5555555555*                                                                                    -6-9525-9536-
09537     00002       4300  FIVEO DC     2,5@*
43000*                                                                                               -6-9536-9538-
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                I-ADD OP              P/L LABEL   OP        OPERANDS
09587     00050       4510  SIXSH   DC     50,6666666666
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